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VCU Campus Tree Plan

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Prepared for:

VCU Office of Sustainability
and
VCU Office of Planning & Design

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1. Introdution

1.1 Plan Purpose

The purpose of the Campus Tree Plan is to provide Virginia Commonwealth University (VCU) with the framework and policy guidelines for the preservation and maintenance of existing trees, planting of new trees and eventual expansion of the urban tree canopy (UTC) on its campuses. There is a need for this plan given the lack of a clear University policy relating to campus trees/tree canopy as well as the current issues/threats facing campus trees (low amount of tree canopy, high percentage of impervious surface area, climate change and potential shrinkage of the tree canopy due to future increased development). The Campus Tree Plan aims to address all of this by aiming to provide VCU with a strategic framework for enhancing the trees/tree canopy on its campuses through the different goals, objectives and actions listed in the plan.

The overall goal of the Campus Tree Plan is to provide a safe, healthy, attractive and sustainable campus forest. This will help to enhance the VCU campuses in terms of aesthetic appearance, energy efficiency and the social/educational interactions that take place through the wide range of benefits that urban trees provide.

Three important albeit secondary benefits of the Campus Tree Plan are;

1) Increasing carbon sequestration through tree plantings to help VCU meet the climate related objectives set out in its Climate Action Plan (CAP),

2) Supporting the ONE VCU Master Plan's Placemaking principle (which seeks to improve the overall aesthetic of VCU's campuses by providing additional places for VCU's community to gather and collaborate through improved streetscapes, increased and more connected open space, and activated street corridors) and the "Front Doors" initiative (which seeks to "improve the first impression of VCU, strengthen the arrival experience and wayfinding around campus, and enhance VCU's overall sense of place and identity" through the implementation of streetscape and landscape elements) in the ONE VCU Master Plan,

3) Supporting certain objectives related to tree planting in the VCU Stormwater Management Plan (SWMP).

Having the Campus Tree Plan support these long-range plans will help improve the University from an environmental and aesthetic perspective while simultaneously allowing for a greater chance of the Campus Tree Plan's objectives to be implemented and helps place a greater importance of trees and tree plantings in those plans.

1.2 Client Description

The primary client for the Campus Tree Plan is the VCU Office of Sustainability. Its mission is to "foster a multi-faceted culture of sustainability, through the responsible use of resources and continuous advocacy for the Richmond community by inspiring behavior change through our own efforts". Advocating for and implementing sustainable practices related to urban trees and the urban tree canopy on VCU's campuses directly supports this mission. Wyatt Carpenter, a Projects and Programs Coordinator in the Office of Sustainability, served as the client contact.

The secondary client for the plan is the VCU Planning & Design division of Facilities Management. The Planning & Design division provides planning and design support relating tothe evaluation, justification and development of facility needs and projects for the university. Despite being the secondary client for the plan, they have a significant role in implementing the recommendations made in the Campus Tree Plan. The client contact at the Planning & Design division is Jeff Eastman who serves as the University Planner. It is important to note that the Office of Sustainability has its own planning process separate from the Office of Planning & Design.

VCU Office of Sustainability

1.3 Plan Outline

This plan is divided into five main sections: introduction, background, methodology, research findings, and an implementation plan. The first part of the plan introduces the VCU Campus Tree Plan study area in the context of the growth and development that VCU has experienced while also examining the current role and state of urban trees and tree canopy. This context sets the stage for the research questions and methodology. Following the methodology, the campus tree plan analyzes the existing conditions in its study area. Goals and objectives were created based on the data gathered from the existing conditions analysis, relevant BMPs (Best Management Practices) utilized by other university campus tree plans and from the meetings and discussions with the clients. Actions were created to help achieve these goals and objectives. The implementation section lists the different organizations that will be involved in implementing the plan along with their individual roles, possible funding streams and provides a timetable for the strategic implementation of the recommended goals, objectives and actions.

2. Background

2.1 Plan Context

VCU is a large urban university located in a densely developed area of downtown Richmond, Virginia. Over the past several years VCU has grown tremendously as a large public research university and an anchor institution within Richmond. With a student population of over 31,000 (as of fall 2018) and a significant amount of building construction and land development on its two campuses (Monroe Park and MCV Campuses), the university's physical growth has been remarkable. However, VCU also has been working towards a more sustainable future and is committed to furthering sustainability in its community and campuses.

Being that VCU is located in Richmond, it is important to put the Campus Tree Plan in the context of the City's urban forestry efforts. Richmond's Urban Forestry Division (UFD) currently maintains over 120,000 city owned trees of more than 80 species (richmond.gov-urban forestry). The UFD is responsible for planting approximately 2,000 new or replacement trees during the planting season (November- April). However, while the City has planted over 2,000 trees annually during previous years (2012-2015), the number of tree plantings has fallen drastically to 136 trees and 316 trees during 2016 and 2017 respectively (richmond.gov-urban forestry). At the same time, Richmond (just like other cities) loses trees every year due to storm damage, age and building construction. While the exact number of trees loss in the city is not known, it is quite possible that the amount of trees lost due to various factors coupled with a significant decrease in annual tree plantings during the recent years has led to an overall decrease in the number of trees/ percentage of tree canopy cover in Richmond.

VCU has experienced tremendous growth during the past several decades with a substantial rise in student population, building construction and land development. The past Fall semester (2018) has seen VCU welcome its largest freshman class ever with the University having a total enrollment of 31,000 students, up from 23,000 in the Fall semester of 2008 (research.schev.edu). Several new university buildings such as the Gladding Residence Center, Institute for Contemporary Art and College of Health Professions have been added during the past several years. Between 2009 and 2018, VCU invested in more than 5.3 million gross square feet of renovation and new construction while the University's investments in capital assets (land, buildings, equipment) grew 8% in 2017 and is more than double what it was in 2007 (masterplan.vcu.edu).

All of this has helped transform VCU from what was originally a merger of MCV and RPI (Richmond Professional Institute) to a large public research university and an anchor institution within the city of Richmond. The past couple decades, especially, have seen VCU focus on integrating itself economically and socially within the Richmond community and on developing important partnerships with the business sector and nearby neighborhoods of the city.

Figure 1: VCU Cabell Library (Newly Renovated)

While VCU's physical growth has been remarkable, the University also has been working towards a more sustainable future and is committed to furthering sustainability in its community and campuses. The University has maintained a strong commitment to sustainability with the signing of the Talloires Declaration and the Second Nature Climate Neutrality Commitment in 2008 (masterplan.vcu.edu). The signing of this commitment led to the creation of the Office of Sustainability as well as the creation of the VCU Sustainability Committee (which oversees the implementation of the Climate Action Plan, recommends GHG emissions reduction projects and communicates with stakeholders to further the objective of the CAP). Additionally, VCU aims to become carbon neutral with no net GHG emissions by 2050. The University aims to achieve this through LEED (Leadership in Energy & Environmental Design) building standards, upgrading fixtures to sustainable alternatives, reducing GHG emissions, and supporting more sustainable means of transportation to, from and within its campuses (masterplan.vcu.edu).

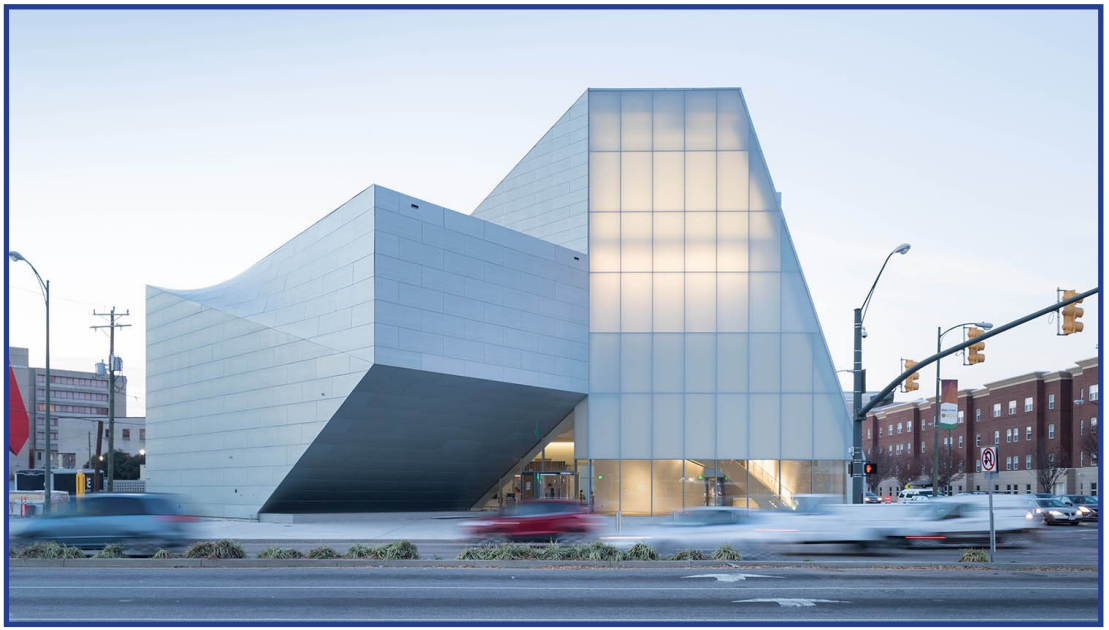
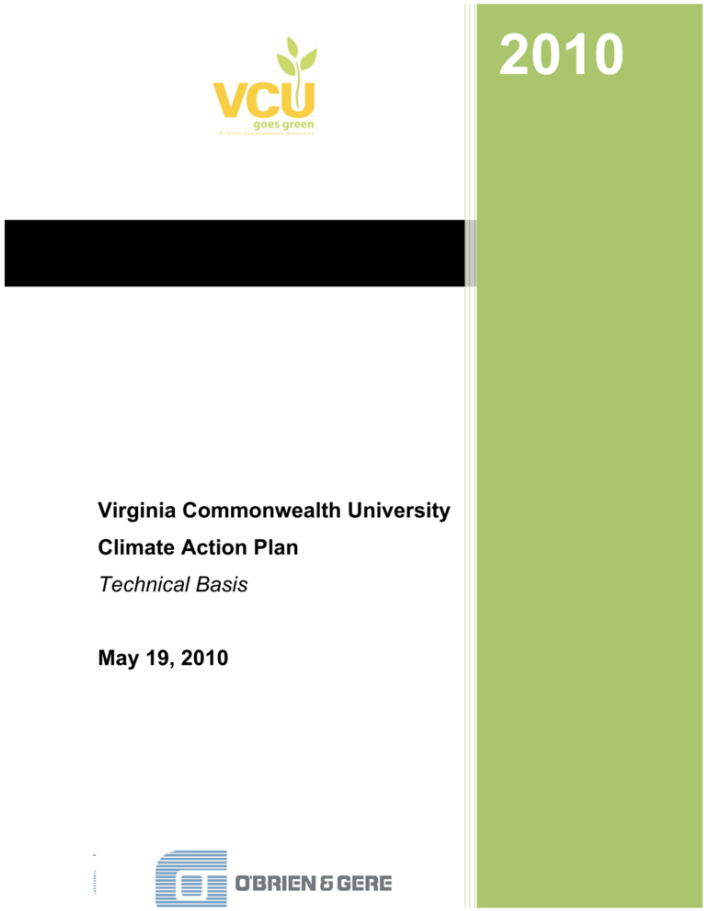


Figure 2: VCU ICA Center (LEED Gold)

Currently VCU has several plans dedicated towards different aspects of the University's planning and design initiatives. The university has already adopted its new strategic plan VCU Quest 2025: Together We Transform, and its Board of Visors recently approved the ONE VCU Master Plan in March 2019. The ONE VCU Master Plan seeks to align VCU's physical environment with the University's strategic plan by coordinating where physical campus investments are made based on the mission and strategic goals of VCU. VCU Health System (a separate entity that shares MCV campus with the University) adopted its own strategic plan (Vision by Design).

Additionally, VCU has a Climate Action Plan (CAP) that commits the university to reduce greenhouse gas (GHG) emissions 17% by 2025 and 100% by 2050. A Stormwater Management Plan (VCU SWMP) was also created by fellow MURP (Master of Urban and Regional Planning) alumni Jesse Harris to help address the impact of stormwater runoff originating from VCU's two campuses. This SWMP is focused on aiding campus planning by identifying opportunities to incorporate sustainable stormwater management practices into future campus projects.



2.2 Exisitng Knowledge

Benefits of Urban Trees

A review of existing literature on the role and state of urban trees and urban tree canopy shows a general consensus in perspectives on this issue. All agree that trees have an important role in the built urban environment by providing numerous benefits to the local environment, people, businesses, communities and economies. At the same time, the current state of urban trees throughout the country does not look promising. Urban trees and tree canopies throughout the world are facing tremendous stress and pressures as we continue to experience rapid urbanization and climate change (Nowak, Greenfield, 2018). More needs to be done to address the issues facing urban trees and ensure that they will thrive into the 21st century and beyond.

Environmental Benefits

One of the main benefits of urban trees is their impact on local environments and climates. All trees sequester carbon dioxide (CO2) from the atmosphere, making tree planting a form of climate change mitigation. They also improve local air quality by helping remove other air pollutants such as sulfur dioxide, nitrogen dioxide, carbon monoxide, other particulate matter, and by reducing ozone formation (Nowak, 2002). Large healthy trees remove 60-70 times more air pollution than younger, smaller trees (Mullaney, et al., 2014).

Additionally, urban trees help to mitigate and moderate summer temperatures in urbanized areas through a number of mechanisms, including (1) reflection, absorption, and diffraction of solar radiation; (2) shading concrete and asphalt, surfaces that more readily absorb and store shortwave radiation, thus minimizing the potential conversion of radiant energy to sensible heat; (3) evapotranspirative cooling of ambient air temperature; and, (4) modification of air flow (Greene et al, 2016). This is a vital benefit for urban areas given the urban heat island effect that cities like Richmond experience annually during the summertime. Extreme heat caused by these urban heat islands pose serious public health risks for cities causing heat related fatalities and illnesses such as heat strokes, heat exhaustion and heat cramps (smv.org).

A recent study conducted in Toronto analyzed the role of urban forest canopy density in moderating summer surface temperatures in the city and found that large areas of high-density contiguous canopy (>40% to <100% tree canopy cover as defined by the study) are more effective at mitigating increases in summer mean surface temperature (or minimizing temperature variation across the built environment) than areas of low-density tree canopy (10-40% tree canopy cover) (Greene et al, 2016). The researchers found that the value of high-density and closed urban tree canopy considerably outweighed the value of low-density canopy from the perspective of urban surface temperature moderation. They concluded that planting efforts should be focused on protecting and expanding existing areas of high-density tree canopy (due to its great importance to summer temperature moderation).

However, they noted that it is unadvisable from the perspective of management to discount the importance of low-density canopy outright, as the ability of low-density tree canopy to moderate urban surface temperatures may be reinforced when in close proximity to areas with other vegetation (i.e., grass or shrubs; higher density classes of canopy). This study demonstrated the importance of urban tree canopy quality to more effectively deliver ecosystem services necessary to the mitigation of summer surface temperature increases in urban environments, (Greene et al, 2016).

Another important function of trees is stormwater reduction. This is particularly relevant for VCU's campuses as they are located in Richmond, which happens to operate a combined sewer system (CSS) in the older parts of the city. A CSS collects stormwater runoff along with domestic sanitary sewage and industrial wastewater into one single pipe system (Harris, 2018). A combined sewer overflow (CSO) event occurs when stormwater and sanitary wastewater exceed the capacity of the sewer system, resulting in pollution and untreated wastewater being directly discharged into surface water (which in Richmond's case happens to be the James River). This leads to high levels of pollutants and bacteria (such as E. Coli) around outfall locations along the James River. In Richmond, as little as 0.2-inches of rain per hour can cause a CSO event.

These CSO events pose a serious public health concern for the populations that utilize these areas (Harris, 2018). Urban trees and forests help reduce surface runoff during periods of heavy rainfall, which reduces the strain on urban stormwater systems. They do this through the interception of precipitation, increased rainwater infiltration, and increased water storage within their soils (Tyrvainen, et al., 2005). It is important to note that trees are inexpensive and easy to install compared to other stormwater BMPs (Carpenter, 2019).

Health Benefits

A secondary benefit of urban trees is the positive health impacts they have for local residents and communities. Rapidly expanding scholarly literature indicates that nature experiences in cities ranging from site to community scale provide health promotion and disease prevention potential for people (Wolf and Robbins, 2015). Studies have shown a correlation between urban trees and forests and the overall health of local residents. These green spaces help promote physical activity, psychological well-being, and the general public health of urban residents (Wolch, et al., 2014; Kaplan and Kaplan, 2003). People are more inclined to go outdoors and take part in exercise when their surroundings/neighborhoods are greener. This increased amount of physical activity results in fewer cases of obesity, which helps reduce other health problems such as diabetes and heart disease (Wolch, et al., 2014).

A recent study conducted in Sacramento analyzed the health promoting potential of trees in an urban area (Ulmer et al, 2016). This study was conducted using high-resolution LiDAR (Light Detection and Radar) and imagery data to quantify tree cover within 250 m of the residence of 7910 adult participants in the California Health Interview Survey (CHIS), then testing for main and mediating associations between tree cover and multiple health measures. Their findings indicated that more tree cover (independent from green space access) within 250 m of home was associated with better overall health, primarily through lower overweight/obesity and better social cohesion, and to a lesser extent through less type 2 diabetes, high blood pressure, and asthma (Ulmer et al, 2016). This study along with other studies suggest an important role for trees in improving holistic population health in urban areas.

Urban trees also offer benefits for mental health as they reduce body and mind stress. This is especially true in high stress environments such as college campuses. Studies have shown that natural environments help people recover from mental fatigue (Kaplan and Kaplan, 2003) while park visits in particular help rejuvenate residents, enhance their contemplation and provide them with a sense of peace and tranquility (Wolch, et al., 2014). Additionally, landscapes with trees and vegetation produce more relaxed physiological states in people than landscapes lacking such greenery (McPherson, 1992).

One prominent study in particular found an association between more streetscape greenery and better mental health status, better social cohesion, and reduced stress. Dutch researchers conducted an analysis on four cities in the Netherlands and their findings revealed that both quantity and quality of streetscape greenery were related to perceived general health, acute health related complaints and mental health. Residents living in neighborhoods with more streetscape greenery perceived their own health as better, experienced less acute health-related complaints, and had a better mental health status than residents living in neighborhoods with less streetscape greenery. When the quality of the streetscape greenery was added, this improved the model even further (de Vries, et al, 2013). This study along with other studies have shown a positive relationship between the availability of local greenery and residents health, which offers opportunities for health improvement for people, particularly those living in dense urban environments such as VCU's campuses.

Safety Benefits

Another overlooked benefit of urban trees is the increased safety they provide to residents and people in their area. Street trees act as visual and physical barriers between motorists on roadways and pedestrians on sidewalk paths by creating a vertical wall between the foot path and the road. Roadside trees provide motorists with a defining edge to help guide their movements and assess their speed, thereby increasing community safety (Tarran, 2009). Urban trees also enhance safety for people by reducing crime levels. Studies have shown a link between urban areas containing a high amount of street trees and reduced crime. Areas with high amounts of vegetation can have approximately 50% lower crime levels than areas with low levels of vegetation (Kuo, et al., 2001). People living in "greener" surroundings report lower levels of fear, less amount of incivilities and less aggressive and violent behavior.

Additionally, larger street trees are associated with a decrease in both the incidence of crime and the fear of crime (Mullaney, et al., 2014). It is worth noting, however, that other factors may contribute to crime being lower where tree canopy is denser, such as affluence. More trees typically are found in wealthier neighborhoods where crime is also lower. However, this isn't to say that there isn't a relationship here between the two. Kuo and Sullivan's study used police crime reports to examine the relationship between vegetation and crime in an inner-city neighborhood and found the greener buildings surroundings were, the fewer crimes reported.

Additionally, the relationship of vegetation to crime held after the number of apartments per building, building height, vacancy rate, and number of occupied units per building were accounted for (Kuo et al., 2001).

Economic Benefits

A third important benefit of urban trees is the positive impact they have on local economies and communities. Due to reliance on air conditioning, the peak urban electric demand rises by 2–4% for each 1°C rise in daily maximum temperature above a threshold of 15 to 20°C (59-68° F). This increased reliance on air conditioning use caused by the rise in air temperature is responsible for 5–10% of urban peak electric demand, at a direct cost of several billion dollars annually (Akbari, et al., 2001). Multiple studies have shown that trees reduce building energy use by lowering temperatures and shading buildings during the summer. Additionally, they also block winds during the winter by acting as windbreakers (Nowak, 2002). By reducing the cost of heating and cooling buildings, urban trees help contribute to energy conservation (McPherson, 1992). As a result, they provide significant energy cost reductions for homeowners and business owners. By reducing the cost of heating and cooling buildings, urban trees help contribute to energy conservation (McPherson, 1992). As a result, they provide significant energy cost reductions for homeowners and business owners.

According to the USDA Forest Service, trees that are properly placed around buildings can reduce air conditioning needs by 30% and can save 20-50% in energy used for heating. However, this depends on the height of the building. Trees primarily help reduce air conditioning needs and energy uses if they are shading the building, particularly the roof. While urban settings such as VCU's campuses do contain large multi-story buildings that are too tall in height to feel the benefits of trees, they still contain other smaller buildings lower in height that are able to benefit from the energy cost reductions provided by trees. Computer models devised by the U.S. Department of Energy predict that the proper placement of just three trees can save an average household between $100 and $250 in energy costs annually. All of this can come in handy for a place like Richmond that tends to have long, hot and humid summers.

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Urban trees also help generate revenue for business owners and business districts. They enhance the attractiveness of an environment, which is an important factor for attracting customers. Both consumers and businesses have been found to favor districts with high tree cover, and these well landscaped areas can be seen as an economic asset for a district (Hastie, 2003). Research done on the economic contributions of trees to retail settings found that consumer behavior was positively correlated with streetscape greening. Green retail streetscapes were perceived as being higher in visual quality and comfort and are expected to feature higher quality products by shoppers. What's more, potential shoppers were willing to travel further and longer, to visit more often and for longer, and to pay more for goods and parking when visiting retail places with trees compared to other retail places and districts that lack trees. Additionally, higher visual quality ratings of retail streetscapes result when a full-canopy forest is present, defining the mood and character of the street. Even if buildings are well maintained, or are of historic character, a lack of street trees and dominance of buildings results in low streetscape ratings among consumers (Wolf, 2004). Urban trees and forests therefore increase real estate values, and this generates higher tax revenue from residential properties and shopping centers (McPherson, 1992). In summary, urban trees and forests provide a business generating and positive real estate transaction appearance and atmosphere.

Current State of Urban Trees in the U.S

Even though urban trees provide a multitude of benefits for people, communities and the environment, they are on the decline throughout the nation. A recent paper written by David Nowak (from the USDA Forest Service) analyzed urban and community tree cover in the U.S and found that it is disappearing at a rate of 36 million trees (175,000 acres) each year (it is important to note that this number isn't just referring to tree loss in urban areas but also due to development of suburban areas adjacent to cities as well).

At the same time, impervious surface cover has increased at a rate of 1% in urban areas over the 2009-2014 period of their study (Nowak, Greenfield, 2018). Their study examined changes in tree cover and impervious cover types within urban/community and urban land in all fifty states and D.C during the period of 2009-2014. Because urban land encompasses more heavily populated areas (population density-based definition) and community land has varying amounts of urban land that are recognized by their geopolitical boundaries (political definition), the category of "urban/community" was created by the researchers to classify the union of these two geographically overlapping definitions where most people live.

Nowak + Greenfield's (2018) findings for Virginia showed that its tree cover has declined by 0.5% (2,070 acres) or 0.1% annually between 2009 and 2014. Additionally, Virginia's impervious cover increased by 0.8% (4,760 acres) or 0.16% per year over the same period (2009-2014). They concluded that this trend of tree loss will likely continue into the future (due to increased development, climate change, diseases, insects, fires) unless forest management/ urban development policies are altered. Implementing tree canopy programs throughout the nation can help sustain desired tree cover levels and better manage land cover change heading into the future.

Impact of Climate Change on Trees

Another important aspect of tree planning relates to the impact of climate change on tree species. As we experience the effects of the changing climate, it is crucial for us to adapt and become more resilient to it. One adaptation that has been largely overlooked is the planting and protection of urban trees (particularly those that are native to their local environment and/or more resilient to climate change) (Ordonez and Duinker, 2014). It is of increasing importance that localities and universities develop urban forest climate adaptation strategies that focus on the planting and stewardship of tree species that are well suited to both the current and future climatic conditions in their site. Having these "climate ready trees" will help foster a smoother transition for urban forests in an era of increasing climate change (McPherson, et al, 2017).

Climate change has several different effects on urban trees and urban forests. One key element is the increase in temperature in the long term, increase in the frequency and intensity of heat waves, and increased temperature variability (maximum and minimum temperature in shoulder seasons). Another direct element of climate exposure is involving a change in quality of precipitation (more or less snow/freezing rain), increase in the frequency and intensity of rain events resulting in flooding, and an increase in the frequency and intensity of droughts (Ordonez and Duinker, 2014). Other direct elements of climate exposure are the frequency and intensity of wind events, and sea-level rise, characterized by an increase in salinity concentrations in fresh water and soil. Additional factors that affect urban forests include air pollution, an increase or decrease in the frequency/intensity of fires, and an increase or decrease in insects and disease outbreaks and effects (Ordonez and Duinker, 2014).

Virginia Climate Summary

The National Oceanic and Atmospheric Administration (NOAA) has climate summaries prepared for all U.S states. Their climate summary for Virginia reveals some key takeaways for the state. Firstly, average annual temperatures for the state have increased by 1.5 F° since the beginning of the 20th century. Under a higher emissions pathway (simulation of current trajectory of GHG emissions assuming warming will continue at its high rate), historically unprecedented warming is projected by the end of the 21st century (Runkle et al, 2017) However, even under a lower emissions pathway, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. Regardless of which pathway materializes, one can expect temperature increases in Virginia and more intense future heatwaves. This will pose human health risks for large metropolitan areas such as Richmond.

Secondly, droughts are projected to be more intense due to higher temperatures that will increase evaporation rates, causing soil moisture to deplete more rapidly. This will negatively affect trees in an urban location like VCU as evaporation steals water from trees. Thirdly, the number of extreme precipitation events are projected to increase (Runkle et al, 2017) Virginia is part of a sizable area across the northern and central U.S that is projected to see increases in heavy precipitation events (both in number and intensity) by the middle of the 21st century. But even if overall precipitation increases, droughts are still projected to become more intense because higher temperatures will increase the rate of loss of soil moisture during dry spells (Runkle et al, 2017). This will outweigh the additional precipitation projected for the state.

2.3 Theoretical Framework

Planners have several roles throughout the planning process, ranging from the researcher, communicator, project manager and facilitator. These roles of the planner are defined through the different theories of planning. These theories help provide a legitimacy to the planning process and guide the process and methods systematically. Additionally, they help define the outcomes that are hoped to be achieved through the planning process. Sustainability and Advocacy Planning are theories of planning that the VCU Campus Tree Plan is based on. They have influenced the design and framework of the plan, specifically the methodology and analysis parts of the project.

Keeping in line with the goal of sustainability theory/planning, the Campus Tree Plan sought to 1) develop an inclusive process on VCU's campuses to define the scope and scale of the problem (how to preserve, maintain and eventually increase the number of trees and overall urban tree canopy on the campuses) and, 2) develop solutions inclusively such as student volunteer tree plantings and service learning opportunities. In order to achieve this, an engagement process was conducted with those in charge of planning and sustainability at VCU (The Office of Planning & Design and Office of Sustainability) while efforts were made to identify other individuals and groups that could play a role in the implementation of the campus tree plan.

This project sought to approach the issue of sustainability by 1) orienting the campus tree plan towards sustainable practices in a gradual and evolutionary progression over the next coming years and decades rather than have it necessarily focused on immediate results, 2) broadening the idea of sustainability for campus trees and urban tree canopy by incorporating it into a more extensive understanding of the different conflicts (need for growth and development of university, need for green spaces and urban forests) within university planning and development and 3) focusing on the local level of sustainability which for this plan would be Monroe Park and MCV campuses.

While sustainability was used as the normative outcome for this professional plan, the process was conducted through an advocacy planning lens. The Campus Tree Plan aims to incorporate this advocacy method by advocating for the stakeholders involved through information/updates on the planning process as well as through substantive solutions for campus trees and UTC in the plan. Since an advocate planner is "responsible to his client and would seek to express his client's views" (Davidoff, 1965, p-431), planning proposals, goals and recommendations provided by the clients during this planning process were incorporated into the final plan document.

3. Methodology

3.1 Research Questions

Table 1 contains a list of the research questions related to the campus tree plan. These questions can be grouped into two broad categories- 1) what are the existing conditions on VCU's campuses (in relation to its landcover), and, 2) what are some strategies and approaches that VCU can implement to improve the state of its trees and tree canopy. The information gathered from the answers to these questions were used to help shape VCU's Campus Tree Plan.

Table 1: Link Between Research Questions, Sources of Information

	Question	Source	Analysis
1.	What is the current state of trees and UTC on VCU's campuses?	GIS data (Richmond tree canopy map package from PhD student Jane Remfert & City of Richmond)	Qualitative Method
2.	What is the current state of impervious surface area on VCU's campuses?	Land cover data from GIS	Qualitative Method
2.	How do VCU's campuses compare with the rest of Richmond in terms of tree canopy and impervious surface area?	Land cover data from GIS	Qualitative Method
4.	What effect do the UTC and impervious surface area have on VCU's campuses?	Richmond urban heat island effect study (including GIS data)	Qualitative Method
5.	What are BMPs relating to tree planning that VCU can use for its campuses?	Existing University campus tree plans	Qualitative Method
6.	What methods can VCU use for increasing trees and tree canopy on its campuses?	Existing University practices	Qualitative Method
7.	What are the existing conditions at VCU in relation to this plan? (strengths, weaknesses, opportunities and threats)	Information from VCU's existing conditions	Qualitative Method

3.2 Sources of Information

A wide range of information sources were drawn upon to answer the research questions listed above. Case studies and existing university campus tree plans were used to help answer many of these questions. VCU maps relating to the campus boundaries and parking infrastructure were analyzed to answer certain research questions relating to the boundaries that will be used for the study area and the amount of surface parking lots on VCU's campuses. Expert interviews with relevant VCU personnel as well as other individuals involved in tree planning and planting in Richmond were used to acquire information and advice. Additionally, GIS maps relating to tree canopy and land cover data as well as the urban heat island effect in Richmond were utilized to provide data on existing conditions for VCU's campuses. All GIS layers are in Lambert Conformal Conic projection. Other sources of information that were used were articles describing standards for campus tree planning. In addition to these, existing long-range plans that VCU already has were reviewed to determine if the Campus Tree Plan could support any of their goals and objectives.

3.3 Expert Interviews

As part of this planning process several interviews were conducted with local experts to gather input, guidance and information pertaining to the focus and direction of the plan. Relevant information obtained from the interviews were used to help guide the planning process and were included in the goals and recommendations of the campus tree plan. Table 2 lists which individuals were interviewed and why they were interviewed while Table 3 contains an interview protocol with specific lists of questions that were asked during the interviews. These questions were grouped into two categories- questions for VCU staff and faculty members, and questions for people that work in tree related organizations within Richmond. It is important to note that an individual that was interviewed wasn't necessarily asked every question that is from their category, just the ones that pertained to their expertise and area of knowledge. Both tables can be found in the appendices section (Appendices A and B respectively).

Table 2: Expert Interviews

Who Is Being Interviewed	Why They Are Being Interviewed
John Chupek (City's Urban Forestry Division)	To gain input on the state of urban trees along with any advice relating to tree planting, preservation and maintenance in Richmond.
Clayton Harrington (Director of Parking and Transportation at VCU)	To inquire about the possibility of converting some of VCU's parking lots into green spaces with trees
Pete Price (Lanscape architect involved with ONE VCU Master Plan)	To gain information on the landscape practices/tree selections being used by his team for the ONE VCU Master Plan and for landscaping/streetscaping on campus in general
Wyatt Carpenter (Office of Sustainability)	To see if there is any data on the current state of urban trees and urban tree canopy in Richmond

As part of the expert interviews outreach method, an interview protocol was developed containing a list of questions that were asked during the interviews. Table 3 has these questions grouped into two categories- questions for VCU staff and faculty members, and questions for people that work in tree related organizations within Richmond. It is important to note that an individual that was interviewed wasn't necessarily asked every question that is from their category, just the ones that pertained to their expertise and area of knowledge.

Table 3: Interviews Protocol

Questions for VCU staff and faculty
1. Are there any specific trees that you prefer to use for tree wells and tree buffers? 2. Are there any other criteria or conditions that need to be met in order to install tree buffers? 3. What are the current and projected demands for parking at VCU? 4. Do you think it is feasible to convert some of the parking lots at VCU into small green spaces with trees?
Questions for people working in tree related organizations in Richmond
1. Are there any major issues facing trees in urban areas? 2. What are some commonly used tree species in Richmond? 3. Are any of these trees resistant to extreme weather events? 4. What is the current state of trees and the UTC in Richmond?

3.4 Analytical Methods

Different methods were used to analyze and evaluate the data that were gathered. Quantitative data was used for the calculations of existing conditions such as the number of trees and empty tree wells, the UTC percentage, number of parking lots and percentage of impervious surfaces for both of VCU's campuses. Another method utilized were Qualitative data, in this GIS maps, were used to show the boundaries of the study areas and the percentages of UTC and impervious surface areas for the study areas.

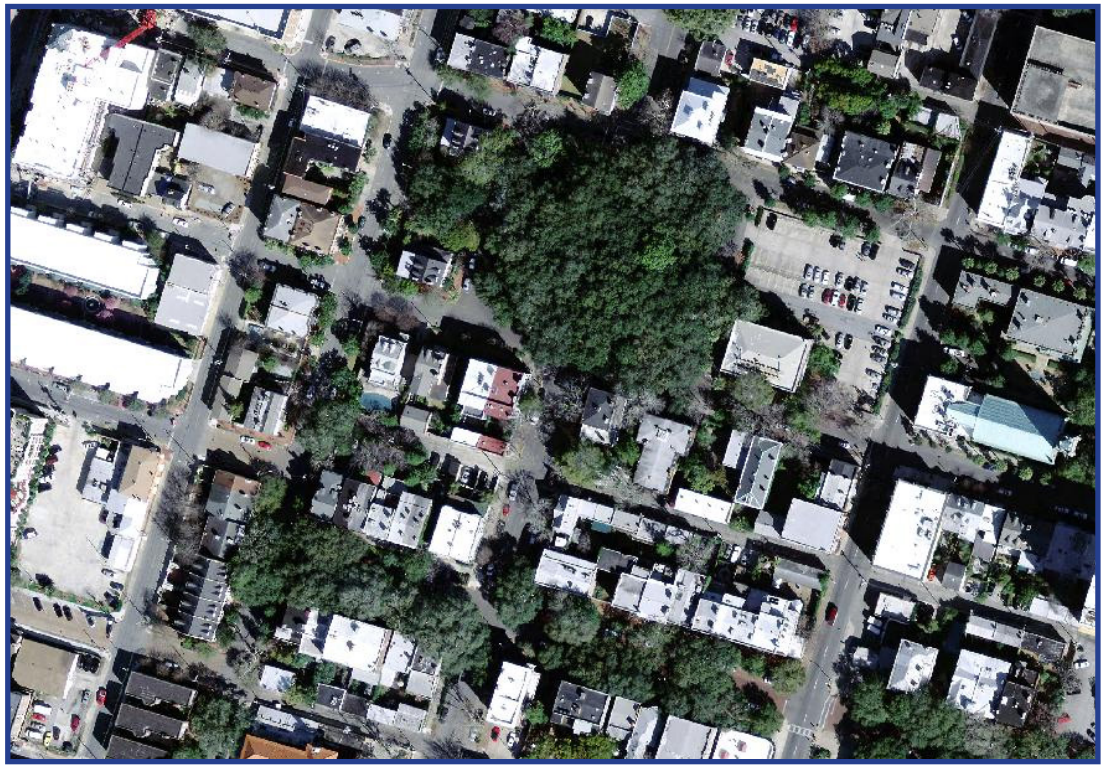
4. Research Findings

4.1 Introduction

The term environmental scanning refers to the "ongoing tracking of trends and occurrences in an organization's internal and external environment that bear on its success, currently and in the future" ("Conducting an Environmental Scan", n.d.). The results are extremely useful in shaping goals and strategies for the planning process. An environmental scan was conducted on the internal (VCU) and external (Richmond) environments to explore existing conditions on VCU's campuses, example plans/BMPs from other universities and localities and methods for increasing trees and the UTC on VCU's campuses and tree organizations.

Before going over the existing conditions for VCU's campuses, it is important to first define what a tree canopy percentage is, why it is important, and why it is an important measure. The UTC percentage is a measurement of the layer of leaves, branches and stems of trees that shelter the ground when viewed from above. Measuring an area's UTC is important as this allows one to quantify its benefits provided by the different ecosystem services carried out by trees (edmondok.com). Having a UTC assessment carried out allows one to measure, monitor and improve tree cover over time. It is important to note that a national analysis by U.S Forest Service researchers found that 40-60% urban tree canopy cover is attainable for cities in forested states (americanforests.org, 2017). Since Virginia is a forested state, this helps to provide some sort of measure for what UTC percentage cities like Richmond should strive for. Figure 3 shows an aerial view of an urban tree canopy when viewed from above.

Figure 3: Aerial Photo of Urban Tree Canopy

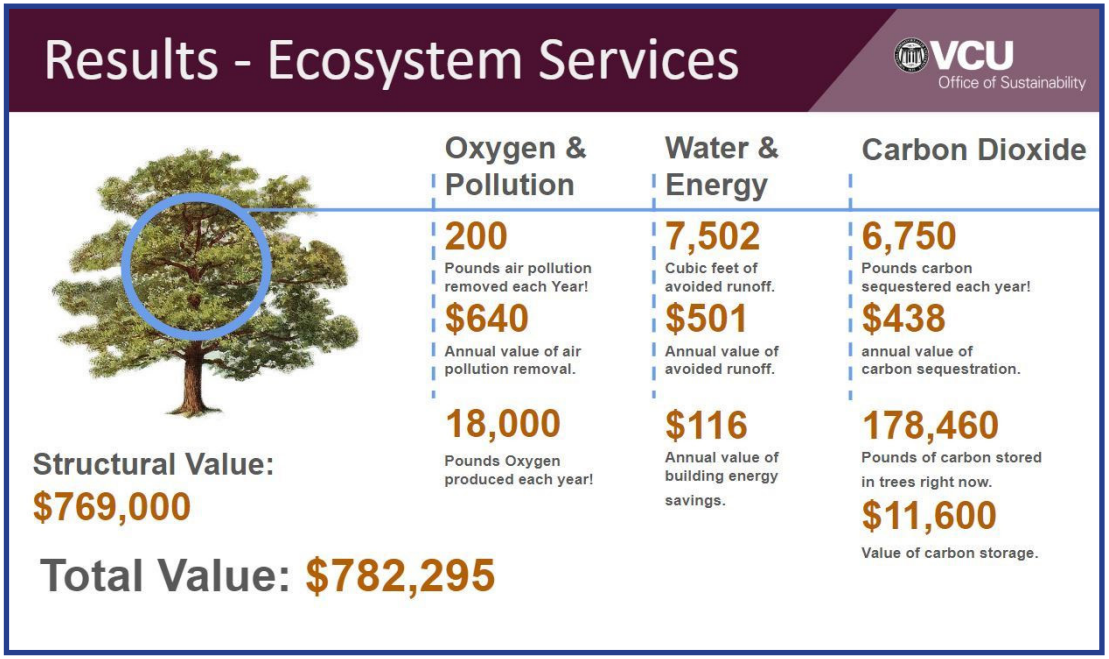


4.2 Existing Conditions

A report conducted in 2010 by Virginia Geospatial Extension Program, Department of Forest Resources and Environmental Management and Virginia Tech on Richmond and other Virginia cities UTC found that the Richmond's total tree canopy percentage at the time was 42% (gep.frec.vt.edu). While this UTC percentage is similar in range to other cities in Virginia such as Arlington (44% UTC), Fredericksburg (44% UTC), Virginia Beach (36% UTC), other cities had higher UTC percentages such as Lynchburg (58% UTC), Radford (53% UTC), Roanoke (48% UTC) and Charlottesville (47% UTC) (gep.frec.vt.edu). Additionally, Richmond's UTC percentage of 42% was on the lower end of the 40-60% UTC recommended by the U.S Forest Service for cities in forested areas.

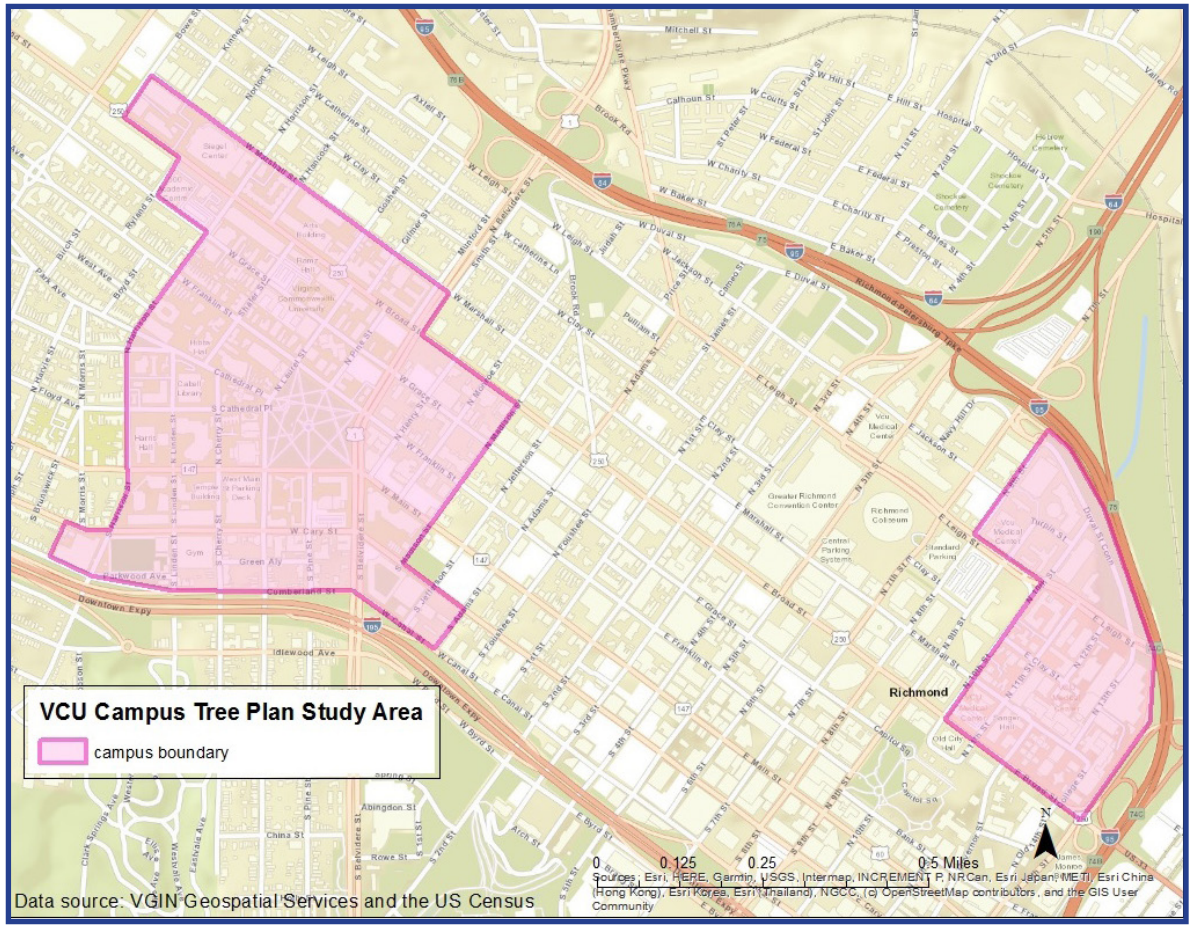
Richmond's UTC was found to be a vital community asset, providing numerous benefits such as improving local air quality, reducing stormwater runoff, enhancing quality of life, providing savings on energy bills and reducing the City's carbon footprint (gep.frec.vt.edu). VCU researchers were able to quantify these benefits for the Carver neighborhood (located adjacent to Monroe Park campus and has one of the lowest tree canopy cover in the City-less than 10% UTC) by analyzing the existing trees in the neighborhood and found that they provide $782, 295 of ecological benefits to Carver (Figure 4 provides more details on the types of benefits provided by trees). Richmond currently has a city-wide average of 26% tree canopy cover as of 2018 (news.vcu.edu).

Figure 4: Tree Benefits



GIS maps were created to describe the current state of trees and the UTC on VCU's campuses. Figure 5 presents the Monroe Park and MCV core campuses' jurisdictional perimeters shown on the VCU police department's website to delineate the study area boundaries used for this plan. Figure 6 a GIS map package was created by Jane Remfert (a PhD student at VCU) to highlight the tree canopy for the City of Richmond. The map package originally came from VGIN (Virginia Geographic Information Network) and Jane Remfert then used census blocks and 'zonal statistics' to calculate how much tree canopy cover was contained in each polygon.

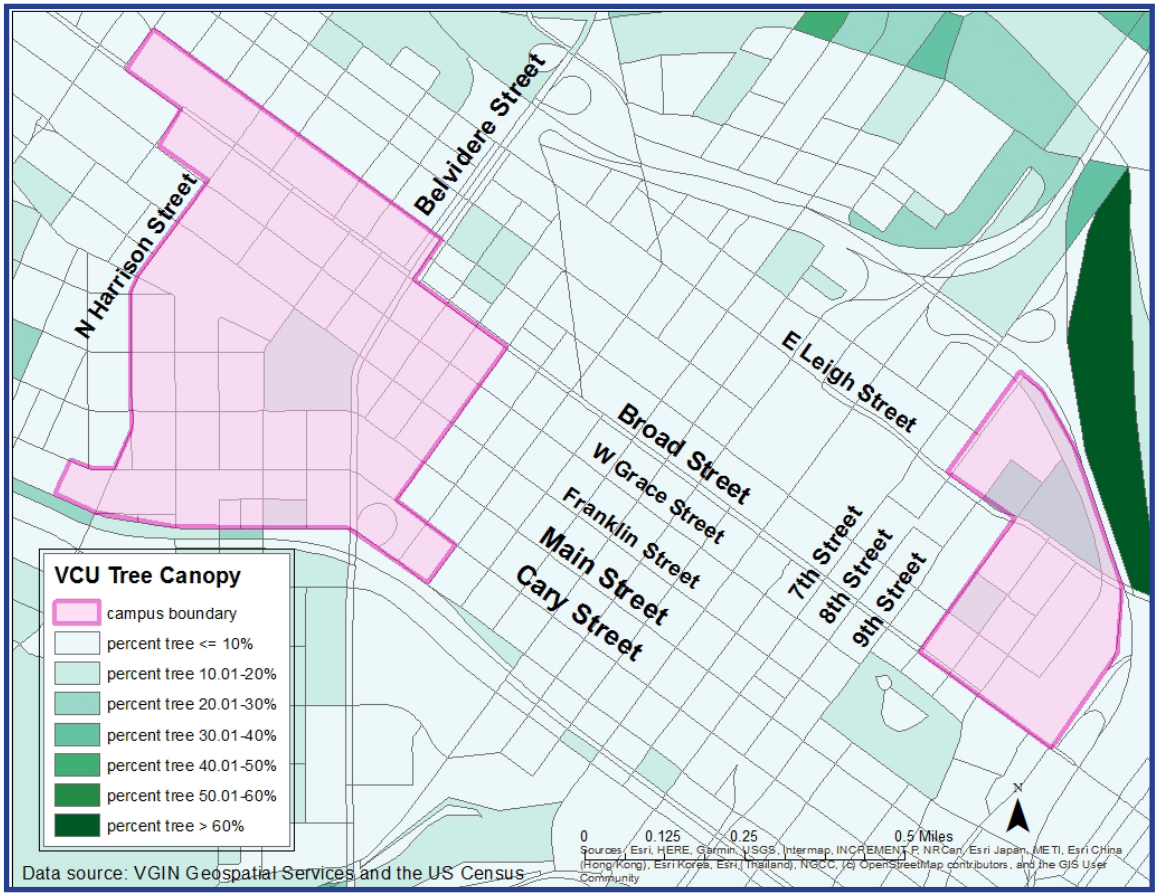
Figure 5: VCU Campus Boundaries



Based on the map package, the overwhelming majority of land (49 out of 51 parcels) for Monroe Park Campus has <=10% tree canopy cover. Only Monroe Park itself and one other parcel have 10.01-20% tree canopy cover. The results are similar on the MCV Campus where a sizable portion of land (8 out of 12 parcels) also has <=10% tree canopy cover (including portions of E Leigh St). Two parcels have 10.01-20% tree canopy cover (one of which happens to be a green along the campus boundary area in between Duval St and the Richmond Petersburg Highway) while another two have 20.01-30% tree canopy.

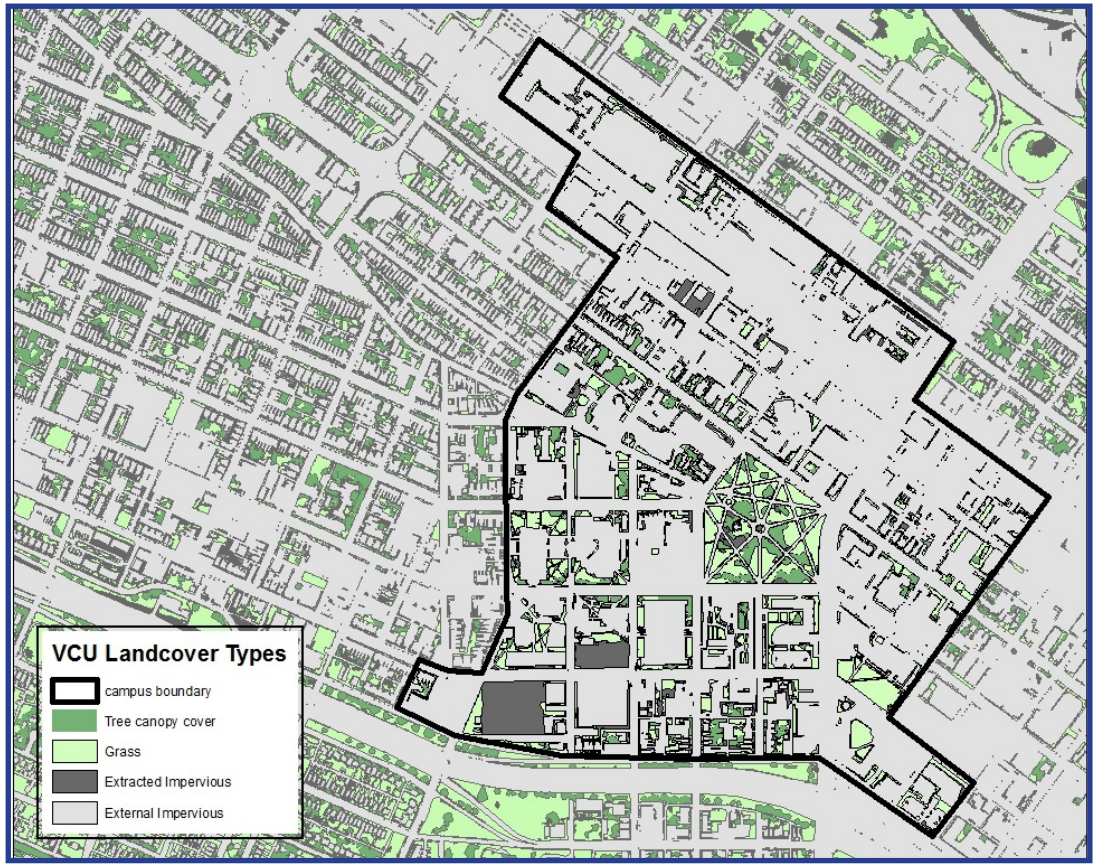
The data shows that both campuses lack significant tree canopy cover on the majority of land parcels within their campus boundaries when compared with Richmond's total UTC percentage of 42% and the city-wide average of 26% UTC. However, VCU's campuses are not the only areas in downtown Richmond that contain low urban tree canopy. The surrounding neighborhoods of Jackson Ward and Monroe Ward (located in between the two campuses) are almost entirely made up of parcels containing <=10% tree canopy cover while the Fan District which also borders Monroe Park campus, is evenly divided between parcels containing <=10% tree canopy cover and parcels containing 10.01-20% tree canopy cover.

Figure 6: VCU Tree Canopy Cover (Percentages)



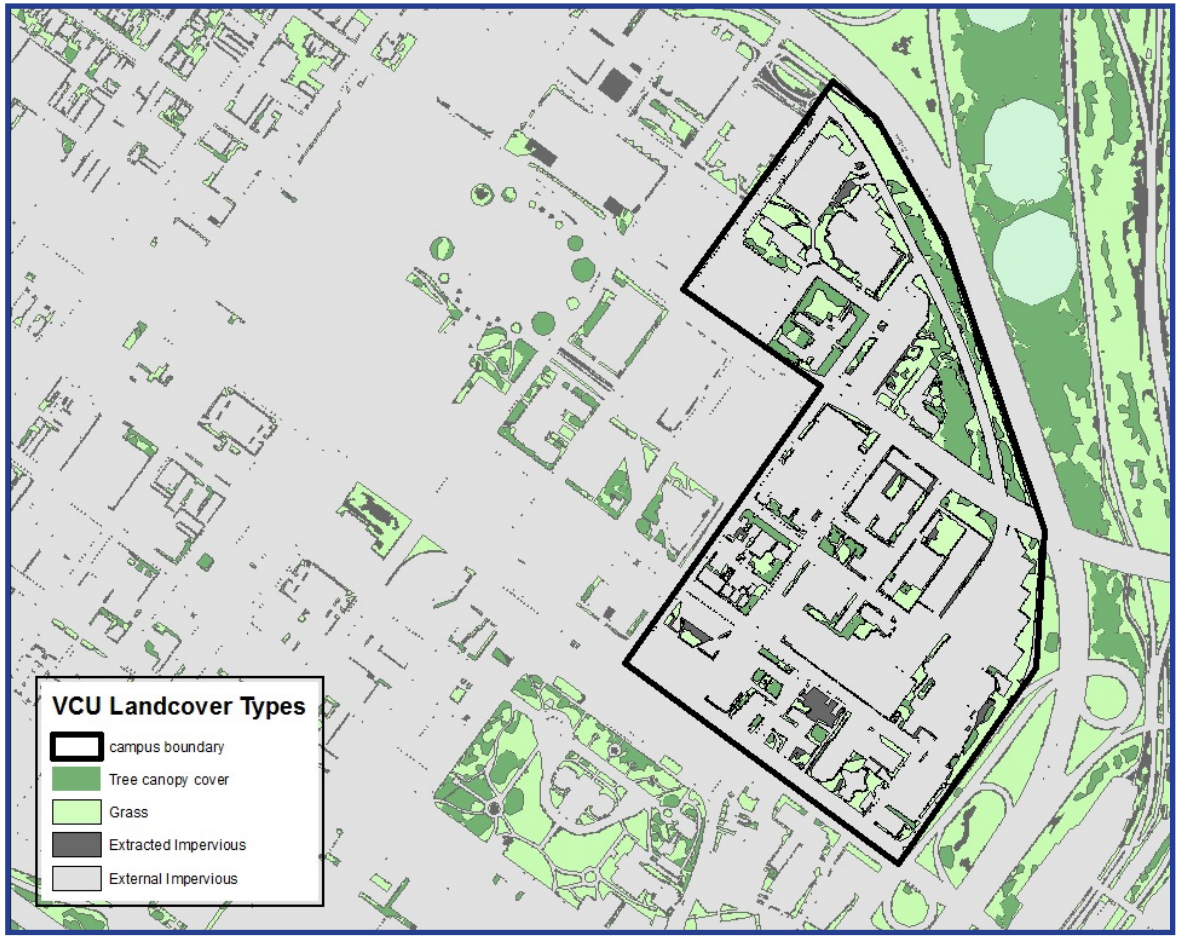
Figures 7and 8 contain the different landcover types; 1) Extracted Impervious (includes areas characterized by a high percentage of constructed materials such as asphalt, concrete, buildings and parking lots, 2) External Impervious (includes locally maintained planimetric data such as buildings, parking lots, edge of pavements and roads), 3) Tree Canopy (includes areas characterized by tree cover of natural or semi-natural woody vegetation as defined by the EPA), 4) TurfGrass (primarily grasses; including vegetation planted in developed settings for erosion control or aesthetic purposes as well as natural herbaceous vegetation and undeveloped land as defined by the EPA)for Monroe Park and MCV campuses respectively.

Figure 7: Monroe Park Campus Landcover Types



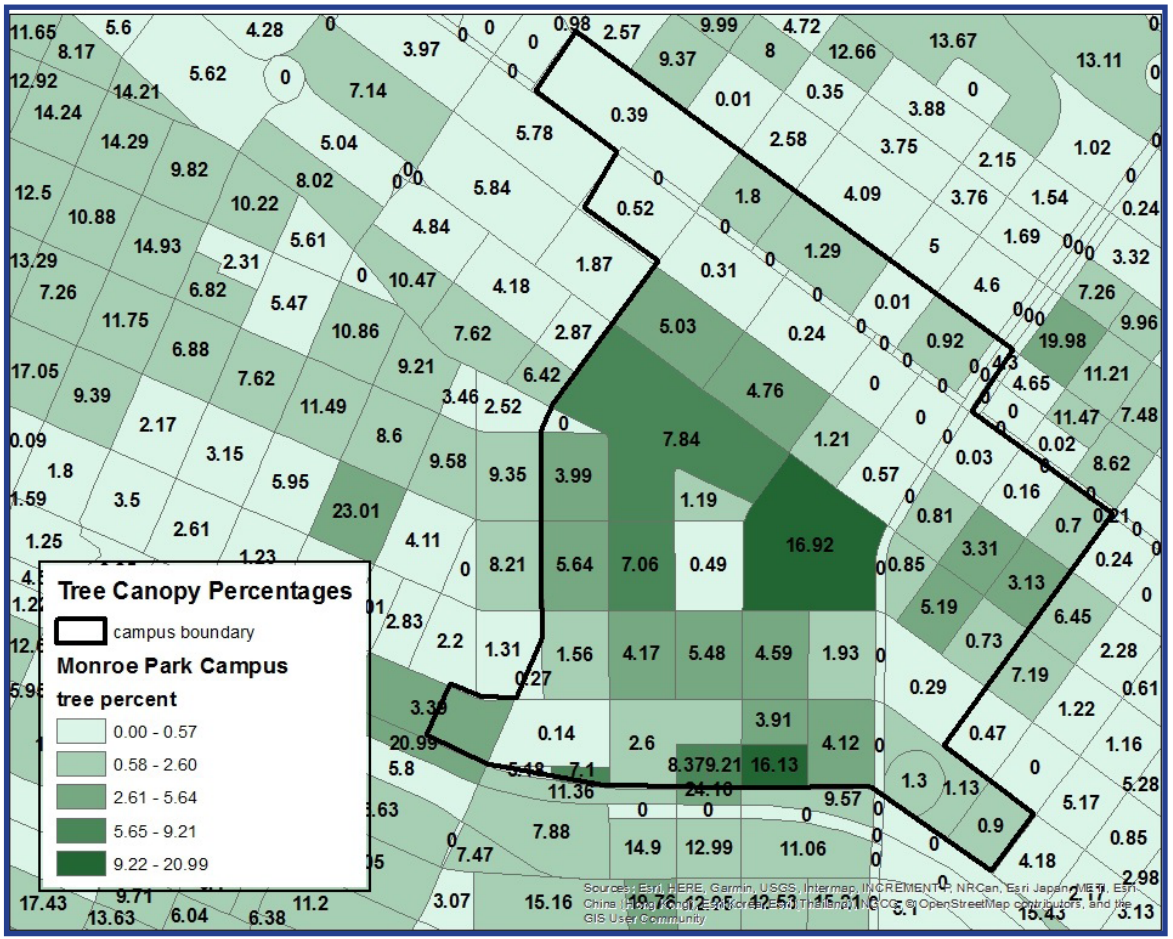
The maps were created by taking landcover data for Richmond and adding the VCU campus boundaries layer to it. The clip tool was then used to extract the area for VCU. Definition queries were then conducted to calculate the amount of total impervious surface areas, total green surface areas (grass and tree canopy) and total tree canopy surface areas. The total amount of impervious surface area (Monroe Park and MCV campuses combined) was 9,466,435 square feet. The total amount for green surface area was 1,792,006 square feet while the total amount of tree canopy alone was 524,969 square feet. The data shows that there is a disproportionally large amount of impervious surface to green space and tree canopy cover on VCU's campuses.

Figure 8: MCV Landcover Types



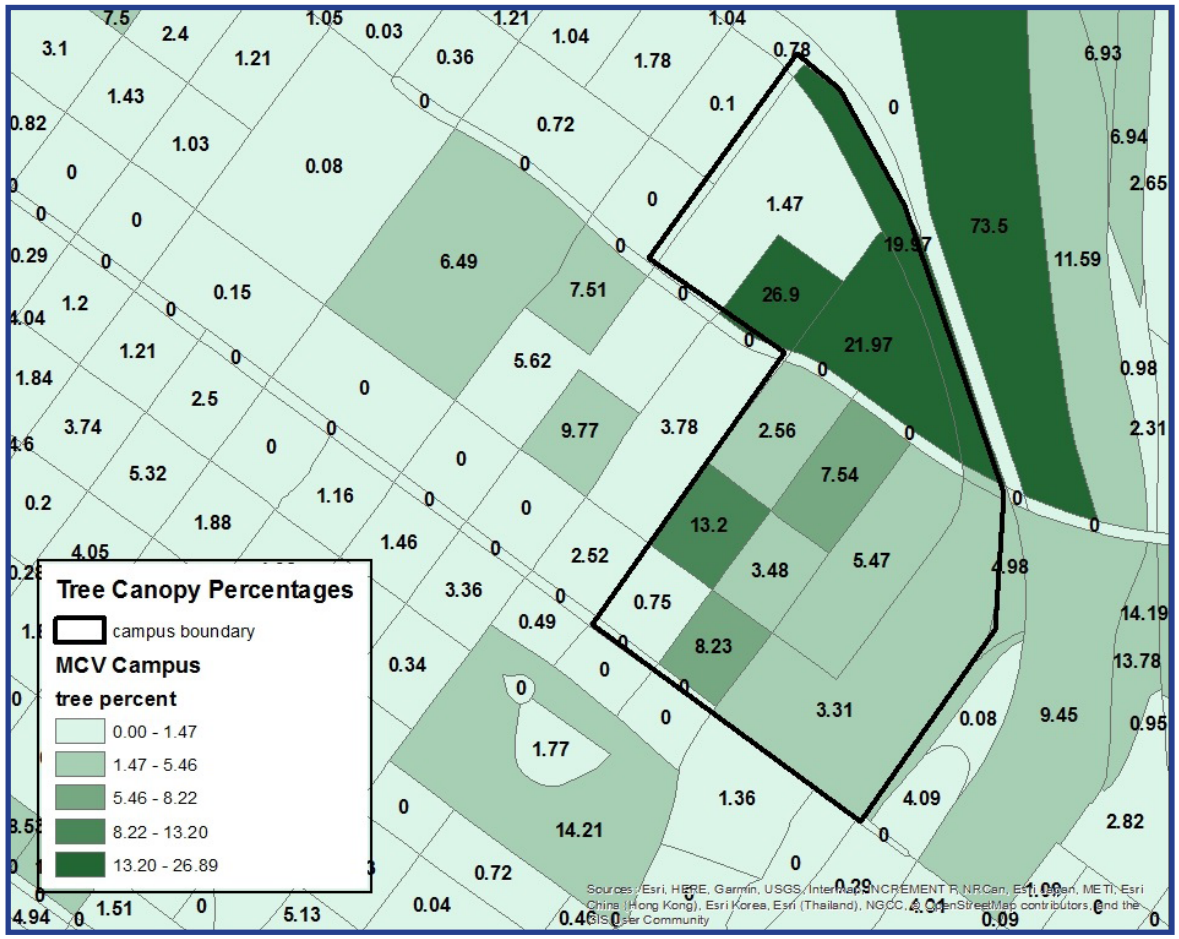
Figures 9 and 10 show the tree canopy percentages for the all the Richmond Census blocks located on the Monroe Park and MCV campuses. The maps were created by combining the tree canopy percentage layer with the d Census blocks. The majority (30) of City blocks on the Monroe Park Campus contained either 0-0.57% or 0.58-2.60% tree canopy percentages. 21 of its Census Blocks had a tree canopy percentage less than 1%. Only 3 Census Blocks (including Monroe Park itself) had a tree canopy percentage higher than 10% (It is important to note that the number of trees in Monroe Park has since been reduced due to renovation, likely impacting this data). The results for the MCV Campus were slightly different as half (7) of its Census Blocks contained either 0-1.47% or 1.47-5.46% tree canopy percentages. 7 of its Census Blocks had a tree canopy percentage less than 5%. Only 4 Census Blocks had tree canopy percentages higher than 10%.

Figure 9: Tree Canopy Percentages fo Monroe Park Campus



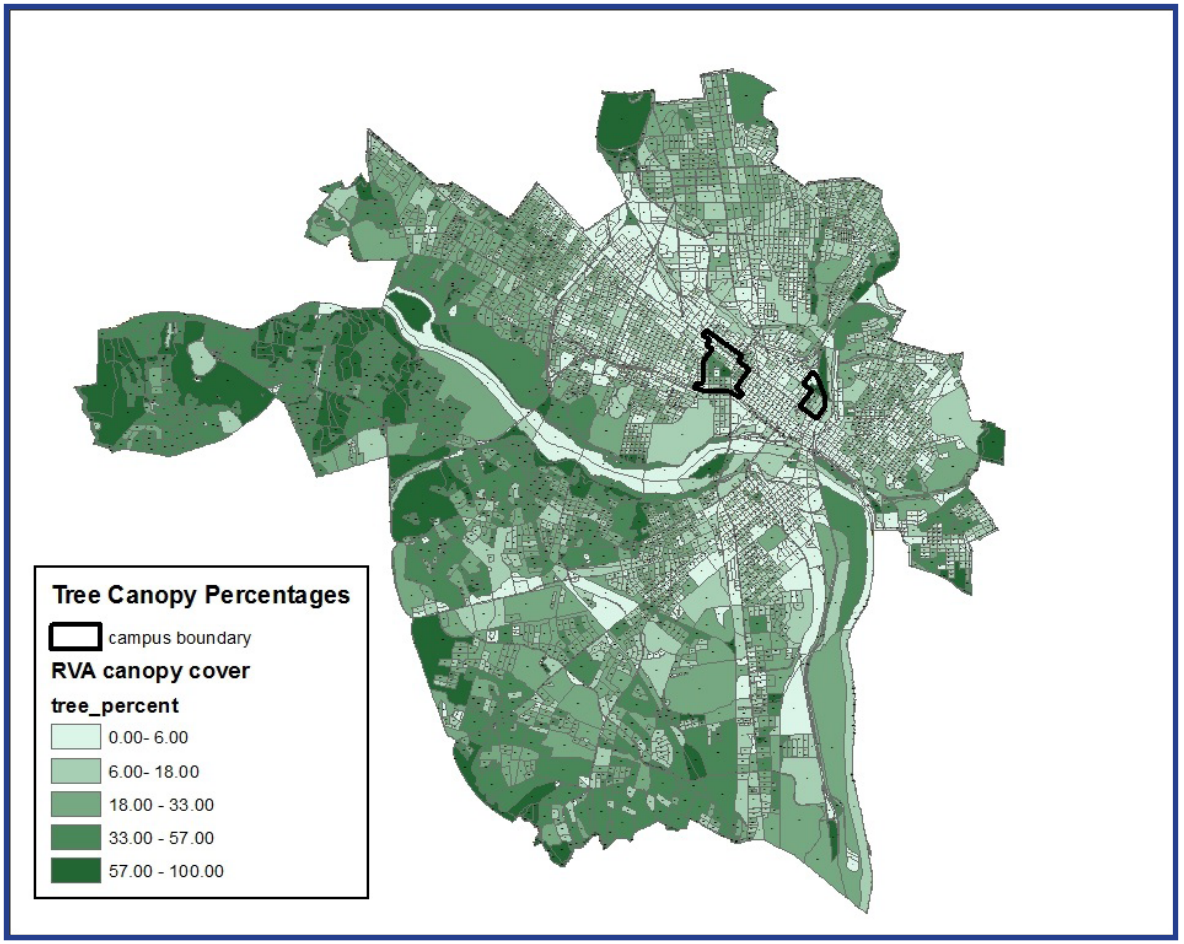
A calculation for the mean tree canopy percentage for both campuses (based on the Census blocks) revealed that the average tree canopy percentage for the Monroe Park Campus was 2.65% while the average for the MCV Campus was 7.98%. The data show that there is a significant amount of Census Blocks on both campuses with low tree canopy percentages. This is even more apparent when compared to the rest of Richmond. Figure 11 shows the tree canopy cover for the City as a whole and downtown Richmond (including Monroe Park and MCV campuses) have an overall lower amount of tree canopy compared to the western and southern parts of Richmond.

Figure 10: Tree Canopy Percentages fo MCV Campus



In addition to the above GIS maps, other data show similar areas of existing tree canopy and impervious surface on VCU's campuses. The Urban Adaptation Assessment (UAA) has an interactive data set for Richmond shows that the census tract in which the Monroe Park campus is located contains 72% impervious surface area and only 7.6% tree canopy ("Urban Adaptation Assessment" n.d). Similarly, the MCV campus contains 72.9% impervious surface area and 4.9% tree canopy. While the census tracts do not correspond exactly to the campus study area boundaries used in this plan (particularly for MCV as the census tract is bigger than its study area boundary in the above GIS map), they provide even more evidence that both of VCU's campuses contain a high amount of impervious surface area and a low tree canopy percentage.

Figure 11: Richmond Tree Canopy Cover

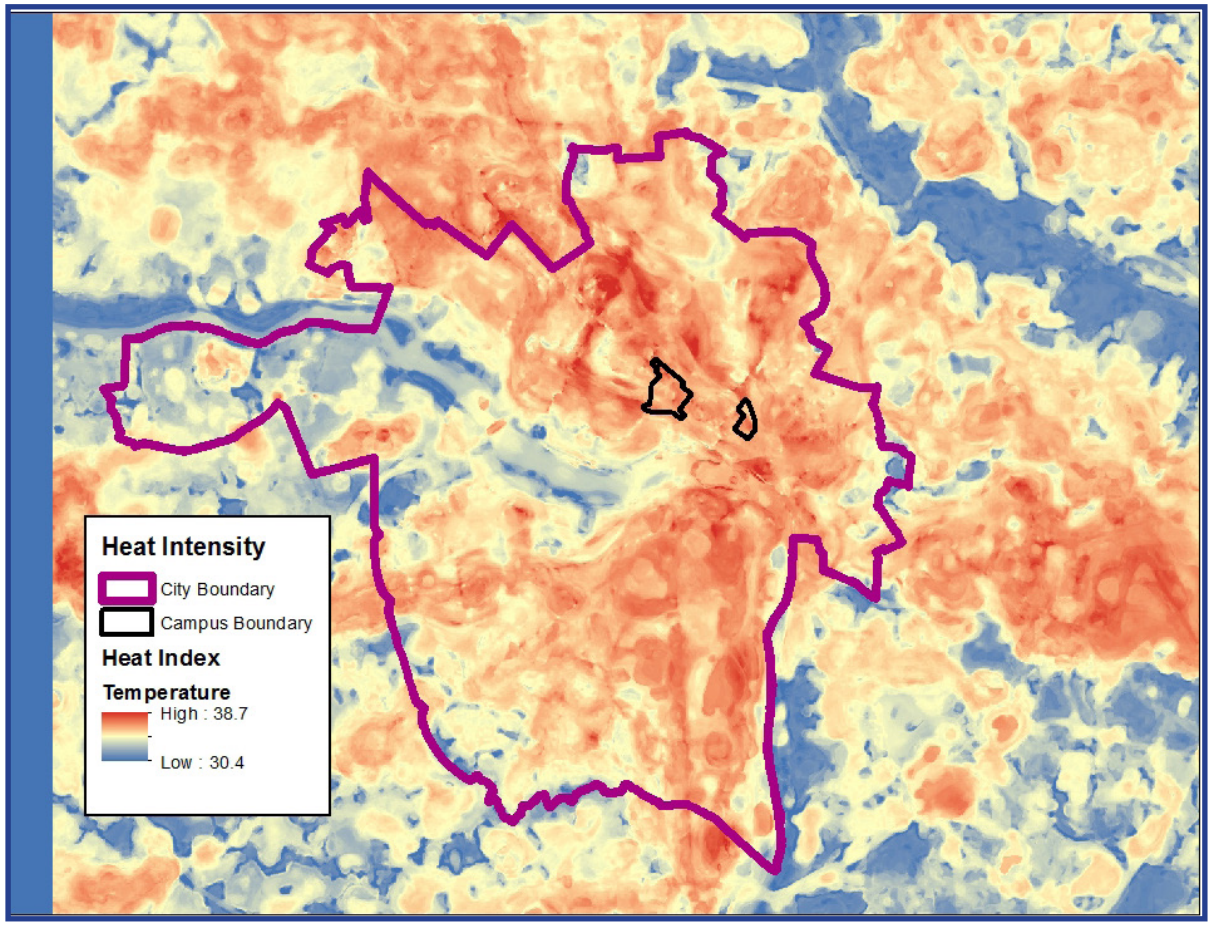


Since the 1970's, Richmond has experienced an increase in the number of days over 95°F per year and climate scientists expect that trend to continue. On these hotter days, Richmond hospitals see an increase in heat-related emergency room visits (toolkit.climate.gov). A recent study conducted by the Science Museum of Virginia in conjunction with the University of Richmond, VCU, Portland State University, GroundworkRVA (a local non-profit) and the City of Richmond Sustainability Office in the summer of 2017, measured Richmond's temperature in various places of the city all at once to analyze its urban heat island effect. Their study identified a ~16°F difference between the warmest and coolest places in the city during the hottest time of the day (3-4 pm).

Figure 12 shows the urban heat island effect for Richmond during the afternoon (the hottest time of the day). This map originally came from Dr. Shandas's team with Richmond City and VCU campuses boundary layers then added on to the raster dataset to provide context for the viewers. As it turned out, the coolest places in the City had plenty of shade and trees while the hottest places were industrial areas with very little tree cover (Shandas, et al, 2019). Areas with low tree canopies and high impervious surface areas (including but not limited to downtown Richmond and its surrounding areas such as Monroe Park and MCV campuses) saw the highest air temperatures. It is important to note that extreme heat is the leading cause of weather-related fatalities over the past 30 years (Shandas, et al, 2019).

All of the above data should be worrying for the University given that its campuses contain low amounts of tree canopy and high amounts of impervious surface area which is amplifying the local urban heat island effect, leaving its students and faculty vulnerable to heat related fatalities and illnesses on an annual basis.

Figure 12: Richmond Urban Heat Island Effect



4.3 Best Management Practices

Before creating a campus tree plan for VCU, existing campus tree plans from other universities were examined to gain insight into the types of practices that they utilize in relation to tree selection, maintenance, oversight and other important aspects of tree care planning. Case studies were selected based on whether they occurred on 1) campuses located in Virginia or nearby geographic locations and/or 2) in urban campuses. Some important themes that were looked at are, 1) types of trees used for tree selections, 2) different categories of tree maintenance, 3) oversight and administration, 4) connect to learning and 5) UTC percentage coverage goals. It is important to note that while all the different university campus tree plans that were examined (both those used as case studies in this plan as well as other university campus tree plans) called for increasing the tree canopy on their campus, they did not provide a specific UTC percentage target with the exception of Georgia Tech which called for a UTC target of 55% on its campus.

Additionally, the Arbor Day Foundation, a nonprofit organization dedicated to tree planting has a Tree Campus USA program that recognizes college and university campuses throughout the United States that 1) effectively manage their campus trees, 2) develop connectivity with the community beyond campus borders to foster healthy, urban forests, 3) strive to engage their student population utilizing service learning opportunities centered on campus, and community, forestry efforts.

In order for colleges and universities to become recognized as a Tree Campus USA college they need to meet the five standards developed to promote healthy trees and student involvement 1) campus tree advisory committee, 2) campus tree care plan, 3) campus tree program with dedicated annual expenditures, 4) Arbor Day observance, 5) service-learning project.

An analysis of existing tree plans at other universities (Virginia Tech, Virginia State, Georgia Tech, Wake Forest and University of Pennsylvania) was done with their recommendations compiled into a series of tables in the Appendices section. The Arbor Day Foundation (which is widely recognized for their tree planning standards) and urban forest management plans from Washington D.C, Charlottesville and Leesburg (these plans were examined for their UTC percentage coverage goals) were also analyzed with their recommendations included in these tables as well. Some high-level conclusions were drawn from these BMPs with a summary of best practices deemed appropriate for VCU listed in Table 4 below. These recommendations can be explored in more depth in the Appendix A below as well as in the links for the different tree plans in references section.

Table 4: Sumary of BMPs for VCU

Tree Selection	o Use both native and exotic tree species o Have sufficient biological diversity of trees o Select the best tree for a given site (site specific) o Establish a list of recommended and prohibited tree species o Ensure a role for Campus Tree Advisory Committee in tree selection process
Tree Maintenance	o Have landscaping and maintenance policies for campus tree care (pruning, mulching, irrigation, fertilization, pest management) o Trees should be removed only when they are a safety concern, are detracting from the quality of the landscape, or when absolutely necessary for new construction projects.
Oversight and Administration	o Responsible Department- University Facilities Management o Establish a campus tree advisory committee
Learning Connections	o Have service-learning projects
UTC Percentage Coverage Goals	o Establish and maintain a tree canopy goal

Planting Street Trees

To assess the feasibility of planting street trees on VCU's campuses an online analysis of the Richmond City Tree Map website was conducted. The analysis found that there are 125 empty tree wells on the Monroe Park Campus (MPC) and 13 on the MCV Campus (as of February 2019). There is also the possibility of adding new tree wells and/or street trees in other areas on the university's campuses. It is important to note that all sidewalks in Richmond, including the tree wells on them, are owned by the City. Any efforts to install new trees on them would require a permit from Richmond to be approved by the City arborist.

Figure 13: New Tree Planting (Harrison Street)

4.4 Methods for Increasing Trees and the UTC on VCU's Campuses

Conversion of Surface Parking Lots

To assess the possibility of converting some of the surface parking lots on the Monroe Park campus (either fully or partially) into green spaces with trees, Clayton Harrington, the Director of Parking and Transportation at VCU, was interviewed (MCV campus was not included for this tree planting method due to high demand for parking there). Currently there are 33 surface parking lots on the Monroe Park Campus. Clayton provided data on the current state of and demand for parking on the Monroe Park Campus. The current inventory for parking by lot/deck for MPC was 5,900 spaces in 2017. The demand for parking in 2017 was 4,200 spaces while projected demand for parking in MPC in 2023 is 4800 spaces based upon 4% growth. Additionally, the 659 surface parking spaces on the MPC are either fully subscribed or function predominantly as visitor parking (Harrington 2018). While the full conversion of the surface parking lots on Monroe Park campus may not be feasible due to current and projected parking demand, VCU can still convert individual parking spots on at least some of the surface parking lots into green spaces with trees.

Figure 14: EE Parking Lot on MPC Campus

Tree Buffers

To assess requirements for tree buffers, Pete Price (a landscape architect working on the ONE VCU Master Plan) was interviewed. Pete mentioned that his team is looking to increase the street edge (new tree buffers) on the "perimeter" of the MPC on Harrison, Boulevard, Cary and Main streets (Price, 2018). He said that they try to use natives tree species as much as possible, and aim towards trees that are readily available, and have strong and upright branching characteristics. He also referred to certain requirements/criteria that need to be met in order to install tree buffers. The size of sidewalks is important, as VCU needs to maintain a minimum of 8' of sidewalk space for walking. Also, sub-surface utilities must be considered, as the City requires plants to be a minimum of 5' away from utilities within the right of way (Price, 2018).

Figure 15: Existing Tree Buffer on MPC Campus

4.5 SWOT Analysis

In order to figure out exactly what is needed and desired for VCU's Campus Tree Plan, a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) was conducted. When conducting this analysis, existing conditions on VCU's campuses, BMPs from existing university and locality tree plans and relevant literature on trees and tree planning were taken into account. After all the analyses were conducted, they were then compared and consolidated into one overall SWOT for the area, as described below.

Strengths

One of VCU's strengths in relation to the Campus Tree Plan is that it already has hundreds of trees between its two campuses, many of which are large and mature. The University also has an indirect strength which is the existing tree related organizations in Richmond (Richmond Tree Stewards, Capital Trees, EnRichmond, City of Richmond Urban Forestry Division) which VCU can lean on for advice and/or collaboration.

Figure 16: Existing Tree Canopy (on Franklin Street)

Weaknesses

In looking at the existing conditions on VCU's campuses, the biggest weakness that stands out is the combination of an overall low UTC percentage and an overall high percentage of impervious cover on the University's campuses. While this is not completely shocking given that VCU's campuses are in urban settings, the fact that the City of Richmond as a whole has 42% of its total land area covered in urban tree canopy with a city-wide average of 26% UTC and only 34.9% in total impervious cover (Richmond's Urban Tree Canopy Report, 2010) while VCU's campuses contain averages of 2.65% (MPC) and 7.98% (MCV campus) tree canopy cover (in census blocks) along with high amounts of impervious surface areas, indicates that there is much room for improvement in relation to the state of trees and the UTC on the University's campuses.

The sizable number of empty tree wells (particularly on the Monroe Park Campus) exacerbates this issue. Additionally, the University lacks a tree replacement policy which can be detrimental to a UTC over time. It is important to note that while tree wells are on City property and are city responsibility, VCU's tree replacement policy would come into play when the University removes trees on its property. The limited amount of space to work with for tree planting, given the densely built up nature of the campuses is another weakness stemming from the existing conditions on VCU's campuses. The last main weakness is that VCU does not currently have a campus tree advisory committee which leaves a void in oversight and administration relating to tree planning on the University's campuses.

Figure 17: Existing Empty Tree Well on MPC Campus

Opportunities

There are some great opportunities for the improvement of the state of trees and the UTC on VCU's campuses. One big opportunity is to have VCU certified as a Tree Campus USA college as this would require the University to take care of several important issues such as having a campus tree advisory committee, tree replacement policy, service learning and budgeting. Another opportunity is having the University either establish or build upon existing partnerships and collaborative efforts with tree related organizations as well as other relevant civic associations in Richmond for its campus tree plan. Having these organizations provide the University with expert advice, tree saplings and volunteers would be of great benefit for VCU. A third opportunity is to plant new trees on VCU's campuses through the different tree planting methods mentioned earlier. This will help to increase the number of trees and the UTC on the University's campuses. Lastly, tree plantings and buffers can be incorporated into the ONE VCU Master Plan through the "Front Doors" initiative as well as other streetscape and green spaces improvements (such as the "iconic green" spaces planned for both campuses).

Figure 18: VCU Front Doors Image (on Franklin and Shafer Streets)

Threats

Several issues could threaten the future of trees and the UTC on VCU's campuses. Being in an urban environment, VCU's campuses have experienced significant new development and construction and will continue to do so for the foreseeable future. While all this new growth and development is largely beneficial for VCU, it could hinder the state of trees and the UTC by strengthening and possibly even increasing the vast amount of impervious surface area that already exists on the University's campuses (an example of this what used to be the grass lawn area next to Snead Hall which is now under construction and will now be largely impervious). Another potential threat for trees worldwide is the impact of climate change in the coming years and decades. Having "climate ready" trees that are suited to both the current and future climate in Richmond can help to mitigate this issue. The other issues that could derail the Campus Tree Plan would be a lack of funding along with a poor implementation of the plan. Having different funding streams available is important for financing the plan, but a specific governing body also is needed to ensure that the plan is properly implemented and enforced.

Figure 19: Location of Former Green Lawn next to Snead Hall

5. Recommendations

5.1 Vision

VCU's two campuses are currently lacking in trees and tree canopy cover. While the University has grown tremendously and made great strides in many aspects of its planning and development throughout the past several decades, much work remains to be done to improve the tree canopy on its campuses. Being in a dense urban environment with a high amount of impervious surface area and limited space for trees has made it challenging to tackle this issue. As VCU continues to develop and begins to face the effects of climate change like the rest of the world, it is crucial that it follows a comprehensive plan that provides a sustainable and long-term strategy for trees and tree planning on its campuses.

The VCU Campus Tree Plan envisions a safe, healthy, attractive and sustainable urban forest for its campuses. To make this vision a reality, VCU will have to devote time, effort and money to implement the list of recommendations stemming from the plan. It is crucial that the VCU offices of Sustainability and Planning & Design take leading roles in the Campus Tree Plan's implementation. However, no single person or entity can fully implement the plan on their own. Collaboration among the various University departments and personnel as well as other stakeholders within the University and the City of Richmond will be vital to the success of the plan both in its initial phase of implementation as well as in its long-term administration and oversight. By following the goals and objectives listed below, VCU can become a model green urban campus with an adequate amount of trees and tree canopy percentages on its campuses.

Figure 20: Conceptual Rendering of New Iconic Green (ONE VCU Master Plan)

5.2 Overviw of Recommendations

The main goals for the Campus Tree Plan are 1) stabilize and expand the UTC on VCU's campuses, and, 2) commit to Tree Campus USA certification. Goal 1 stems from the clear need to protect and increase trees and the UTC on VCU's campuses. based off the research findings. Pursuing Goal 2 will take care of several aspects of campus tree planning such having a campus tree advisory committee, budgeting, service-learning, etc. Table 5 below lists the goals along with the objectives for each goal and the actions that need to be taken to achieve them. These objectives and actions are explained in further detail after the table.

Table 5: Recommendations

Goal 1) Stabilize and expand the UTC on VCU's campuses
Objective 1.1 Preserve and maintain existing trees and the UTC
Action 1.1.1 Adopt a tree replacement policy
Action 1.1.2 Adopt a list of criteria to be met determining if a campus tree should be taken down
Action 1.1.3 Adopt a list of BMPs for tree maintenance
Action 1.1.4 Establish and maintain a campus tree inventory
Action 1.1.5 Have policies in place to protect trees in VCU's campuses against climate change
Objective 1.2 Plant new trees
Action 1.2.1 Adopt targets for total UTC coverage for VCU's campuses by 2040 (10% for MPC & 15% for MCV)
Action 1.2.2 Plant new trees via tree wells on VCU's campuses
Action 1.2.3 Install additional tree plantings and buffers on VCU's campuses
Action 1.2.4 Install small green spaces with trees on the surface parking lots on Monroe Park Campus
Action 1.2.5 Plant new trees outside of campus
Goal 2) Have VCU obtain and commit to Tree Campus USA Certification
Objective 2.1 Create oversight/administration for campus trees
Action 2.1.1 Create a Campus Tree Advisory Committee
Action 2.1.2 Create a campus tree program with dedicated annual expenditures
Objective 2.2 Educate students on campus trees
Action 2.2.1 Arbor Day Observance

5.3 Goal 1: Stabilize and Expand the UTC on VCU's Campuses

Objective 1.1 Preserve and maintain existing trees and UTC

In order to achieve Goal 1, there needs to be a coordinated effort led to preserve and maintain the trees and the UTC that currently exists on VCU's campuses so that they do not decline any further. There are several actions that can be taken to protect VCU's existing tree cover. By preserving and maintaining trees and UTC on the University's campuses, this will provide VCU with a launching pad for which it can then focus on expanding its UTC.

Action 1.1.1 Adopt a tree replacement policy based on a tree caliper replacement ratio

The City of Richmond usually plants 1 ½" caliper (measurement of the diameter at breast height of a tree) trees either as new trees or trees replacing dead or diseased trees. The City has an ordinance prohibiting the removal of live, healthy, City owned trees (Chupek, 2019). However, if a live tree is to be removed (through a variance to the municipal tree policy) then the City usually requires a caliper inch for caliper inch replacement (Ex. If a 45" caliper live tree is removed, the applicant of the variance would need to replace the lost tree asset by planting or paying the City for (30) quantity 1 ½" caliper trees- 30 X 1 ½ =45). This is due to a small tree not being able to replace the lost canopy and benefits of a larger tree; thus, the caliper inch for caliper inch replacement (Chupek, 2019). VCU should aim to follow this tree caliper replacement ratio in its own tree replacement policy.

Action 1.1.2 Adopt a list of criteria determining if a campus tree should be taken down

Based off of the previous BMP tables in the research findings section, VCU should only remove trees on its campuses if they 1) happen to be a safety concern, 2) are detracting from the quality of the landscape or 3) when absolutely necessary

Action 1.1.3 Adopt a list of tree maintenance practices and procedures for VCU's campuses

Based off of the previous BMP tables in the research findings section, VCU should develop specific guidelines for pruning, staking, mulching, irrigation, fertilization, pest management as well as a list of prohibited practices for its campus trees. These tree maintenance BMPs can be adopted from the other existing university campus

Action 1.1.4 Establish and maintain a campus tree inventory

VCU should establish and maintain a tree inventory in GIS for the total amount of campus trees as well as for the total amount of new campus tree plantings. This will allow the University to keep track of its trees on an annual basis as well as allow it to see whether the amount of its campus trees/tree canopy is increasing, decreasing or staying level each year. When conducting the tree inventory, a list should be made noting the tree presence, species, canopy area, canopy height, canopy condition, utility conflict and an assessment for pests and diseases. In order to complete an inventory of campus trees there will need to be 1) a GIS layer of the current tree inventory, 2) a tablet to collect data on (or a paper datasheet if tablets are not available), 3) people to conduct the inventory, 4) people to organize and present the final data and 5) a data manager to keep track of the data year to year. This action can be implemented by the Office of Sustainability however, they will likely need some support from VCU Facilities Management. Collaboration with local tree organization can also be utilized to help achieve this action.

Action 1.1.5 Have policies in place to protect trees in VCU's campuses against impacts of climate change

VCU should 1) conduct vulnerability assessment(s) for campus trees, 2) adopt a list of climate change adaptation strategies and approaches for its campus trees. The vulnerability assessment should firstly identify which campus trees currently planted on campus will be at risk of decline under different climate change scenarios and then see which trees from the City's approved tree species list will be most resilient to current and future climate vulnerability. These assessments can be conducted by the Office of Sustainability in collaboration with the Center for Environmental Studies and/or the urban planning department (potentially as a thesis project for a graduate student).

VCU should use the USDA's (U.S Department of Agriculture) Forest Service's Forest Adaptation Resources workbook as a guide when creating its own policies and BMPs to protect its trees from climate change. The Forest Adaptation Resources workbook focuses on climate change tools and approaches for land managers with an entire section devoted to urban forest adaptation strategies and approaches.

Specific adaptation strategies VCU can use (but not limited to) are

- Strategy 2. Reduce the impact of biological stressors,
- Strategy 5. Maintain and enhance species and structural diversity and,
- Strategy 9. Facilitate composition adjustments through species transition.

Each strategy contains several approaches along with specific examples of adaptation tactics that can be used for implementation. Appendix B provides more detail on the strategies and approaches listed in the workbook.

Objective 1.2 Plant new trees

Several actions that can be taken to expand VCU's existing tree cover during the following years and decades. By following these actions, VCU will be able to provide a safe, healthy, attractive and sustainable campus forest for the University while also enhancing its campuses in terms of aesthetic appearance, energy efficiency and the social/educational interactions that take place on the campuses through the wide range of benefits that urban trees provide.

Action 1.2.1 Adopt targets for total UTC coverage for VCU's campuses by 2040

VCU should at a bare minimum maintain the baseline canopy on its campuses regardless of development with an aspirational target of increasing the UTC over time. The University can aim to adopt separate targets of 10% total UTC percentage coverage for the Monroe Park Campus and 15% total UTC percentage coverage for the MCV Campus by 2040. The reason for having separate targets for the two campuses is that the Monroe Park Campus's current average UTC percentage coverage is significantly lower than that of the MCV Campus. These specific target numbers were chosen based off a comparison of Richmond's average UTC percentage (26%) with the current average UTC percentage coverage on VCU's campuses (2.65% for MPC and 7.98% for MCV). Low target numbers were chosen so that the University could have a realistic chance to reach them given the tree planting constraints VCU has due to its location in a highly dense area within downtown Richmond. Providing 20 years for these targets to be met will give ample time for the tree canopy to grow and mature. The Office of Sustainability can be in charge of implementing this action.

Action 1.2.2 Plant new trees via tree wells on VCU's campuses

New trees should be planted in empty tree wells that currently exist on the Monroe Park and MCV campuses. Additionally, the planting of new trees can also be carried out through the creation of new tree wells on VCU's campuses. Potential areas where new tree wells can be created are (but not limited to) 1) Parkwood Avenue (directly behind the Cary St. Field), 2) Harrison Street (between Grace and Franklin streets), 3) Marshall Street (between N. 11th and N 10thstreeets). In order to plant trees in new or empty tree wells, the University would have to work in conjunction with the City of Richmond since the City owns the rights of way.

Action 1.2.3 Install additional tree plantings and buffers on VCU's campuses

The installation of tree buffers should be undertaken on VCU's campuses. These tree buffers can be similar in nature to existing tree buffers (such as the ones on Floyd Avenue and Linden Street). In order to install tree buffers, the University would have to work in conjunction with and gain permission from, the City of Richmond since the City owns the rights of way. The installation of tree buffers can be implemented as part of the VCU "Front Doors" initiative (part of the ONE VCU Master Plan).

Examples of where trees can be used in streetscape improvements include (but not limited to) Broad (between N Allen Avenue and N 14th Street), Belvidere (along the median between W Canal Street and Leigh Street), Franklin (between Ryland Street and 9th Street), Harrison (between Broad Street and Cumberland Street) and Grace streets (between Ryland Street and N Monroe Street). Additionally, tree plantings and buffers can be used for other green spaces improvements such as the "iconic green" for the Monroe Park Campus (currently the site of the existing student commons and Temple Building) along with the Campus Central Green and Plaza at 9th and Turpin Streets on the MCV campus. This action would be carried out by VCU Facilities Management.

Action 1.2.4 Install small green spaces with trees on surface parking lots on Monroe Park Campus

Small rain gardens with trees can be installed on at least some of the surface parking lots on the Monroe Park Campus. Figure 10 contains a MPC map with all the parking lots and decks from VCU Parking & Transportation. Potential locations for rain gardens with trees are (but not limited to) the BB, EE, HH, JJ and QQ surface parking lots (highlighted in red). This action would be carried out by VCU Facilities Management.

5.4 Goal 2: Commit to Tree Campus USA Certification

Objective 2.1: Create oversight/administration for campus trees

In order to achieve Goal 2, VCU will need to create oversight/administration for the trees on its campuses. There are some actions that VCU can take to achieve this. By creating oversight/administration for its campus trees, VCU will then be able to focus on meeting the other criteria for Tree Campus USA certification.

Action 2.1.1 Create a campus tree advisory committee

VCU should create a campus tree advisory committee with at least one representative from the student body, VCU faculty/staff and the community. Specific members that can be included for VCU's committee are (but not limited to), the landscape architect in the Office of Planning & Design Office of Sustainability coordinator, a member from the Office of Planning & Design, representative(s) from local community and tree organizations in Richmond, representatives from the City of Richmond and VCU Facilities Management (Grounds Supervisor or Superintendent). Although responsibility for many of the campus trees at VCU ultimately lies with the City of Richmond, the Campus Tree Advisory Committee can assist by providing guidance for future campus tree planning, approval and updates of a comprehensive campus tree plan, education of the campus population as to the benefits of the campus trees, and development of connectivity to the community.

Action 2.1.2 Create a campus tree program with dedicated annual expenditures

VCU should establish a campus tree program with dedicated annual expenditures. Evidence will need to be provided showing that an annual work plan has been established and expenditures dedicated toward that work plan when applying for Tree Campus USA certification. Based off the Arbor Day Foundation's suggestion, VCU should work towards an annual expenditure of $3 per full time enrolled student at the University. Since VCU had 31,076 students enrolled as of Fall 2018, this would equal to a total annual expenditure of $93,228. Expenditures can include (but not limited to) 1) cost of trees purchased, 2) labor, equipment, supplies for tree planting and maintenance, 3) value of volunteer labor, 4) staff time dedicated to campus tree planning.

Objective 2.2: Educate students on campus trees

In order to achieve Goal 2, VCU will need to create activities that educate its students on their campus trees. There are actions listed by the Arbor Day Foundation that VCU can implement on its campuses. By following these actions, VCU will be able to complete the remaining requirements needed for it to obtain Tree Campus USA certification.

Action 2.2.1 Arbor Day observance

The Office of Sustainability should plan and organize the Arbor Day Observance for VCU. The observance can be held on one of VCU's campuses where the campuses are located. (The Arbor Day Foundation provides free materials on their website to help promote

Action 2.2.2 Have a service-learning project to educate students on campus trees

VCU should focus on setting up volunteer tree plantings and tree maintenance and establishing a tree inventory for its campuses. Currently VCU has existing partnerships with organizations such as Carver Area Civic Improvement League, Richmond Tree Stewards and Capital Trees. The Office of Sustainability has already conducted volunteer tree planting programs in the Carver neighborhood and can expand on this while also organizing other future volunteer tree plantings, maintenance and an establishment of a campus tree inventory in conjunction with these and other organizations in Richmond. VCU should utilize existing service-learning programs relevant to trees such as (but not limited to) BIOL 497: Ecological Service-Learning and VCU ASPIRE (Academic Scholars Program in Real Environments), and partner with them to help implement this action.

The University could also set up additional sustainability service-learning courses focusing on trees as course credits for university students. These new service-learning courses can take place either on or off campus and would focus on a variety of tree related issues such as 1) general student education, 2) planting trees as part of as a carbon offset project, and 3) replacing trees that could not be replanted on campus in off campus sites due to campus space constraints.

TThe neighborhoods of Jackson Ward and Monroe Ward in particular, are ideal locations for any off campus tree plantings since they both have low UTC percentages, are located in between VCU's two campuses and would support the streetscape improvements envisioned as part of the ONE VCU Master Plan. Lastly, the University can also create an annual event where the new freshman's class can select a new tree to be dedicated and planted in honor of their class each year (a similar event can also be held for VCU alumni as well). The service-learning project(s) chosen would need to be done within the course of the year Tree Campus USA application is submitted.

6.Implementation

6.1 Implementation Summary

An implementation schedule for the Campus Tree Plan has been developed which focuses on the time that each recommendation should be implemented. Each individual action was entered into the implementation table below. Some of the actions can be implemented within a year or two while others should be implemented later on. The schedule covers over a 21-year period, beginning in 2019 and reaching the end in 2040. However, it is important to note that while the implementation timeline of this plan ends in 2040, this does not mean that the work for campus tree planning at VCU will have been completed by then. Rather, the campus tree plan, along with its goals and objectives, may evolve over the years to meet the changing needs of campus trees and tree canopy as well as address any unforeseen challenges or obstacles that may arise in the future (The Campus Tree Advisory Committee will play a key role in addressing any future issues and needs of campus trees).

However, acquiring grants from local or state governments or getting private donors to help with financing are other possible funding streams that the University should examine. Some grants that can be looked at for use for the Campus Tree Plan are (but not limited too) the Virginia Trees for Clean Water and Urban and Community Forestry Assistance Program grants from the Virginia Department of Forestry as well as grants from the VCU Division Community Engagement (as these grants were utilized for funding various aspects of the Carver neighborhood tree planting project). It is hoped that by 2040, the recommendations of this Campus Tree Plan will be fully implemented.

The VCU Office of Sustainability, the Office of Planning & Design, and VCU Facilities Management will be the primary parties responsible for implementing this plan. Collaboration with the VCU Health System will be needed for implementing the recommendations on the MCV Campus. Coordination with the City of Richmond will be needed in order to plant trees on City owned rights of way. In terms of funding, much if not all the cost of implementing this plan will have to come from the University's budget (VCU can work towards an annual expenditure of $3 per full time enrolled student at VCU as recommended earlier in Action 2.1.2).

6.2 Implementation Schedule

Table 6: Implementation Timeline

Recommendations	Short Term 2019-2020	Medium Term 2021-2025	Long Term 2025-2040
Goal 1. Stabilize and expand VCU's UTC			
Objective 1.1 Preserve and maintain existing trees and UTC			
Action 1.1.1 Adopt tree replacement policy			
Action 1.1.2 Adopt list of criteria determining if a campus tree should be taken down			
Action 1.1.3 Adopt a list of BMPs for tree maintenance			
Action 1.1.4 Establish and maintain a campus tree inventory			
Action 1.1.5 Have policies in place to protect trees on VCU's campuses from climate change			
Objective 1.2 Plant new trees			
Action 1.2.1 Adopt targets for total UTC coverage for VCU's campuses			
Action 1.2.2 Plant new trees via tree wells			
Action 1.2.3 Install additional tree plantings and buffers			
Action 1.2.4 Install small green spaces with trees on surface parking lots			
Goal 2. Committ to Tree Campus USA certification			
Objective 2.1 Create oversight and administration for campus trees			
Action 2.1.1 Create a campus tree advisory committee			
Action 2.1.2 Create a campus tree program with dedicated annual expenditures			
Objective 2.2 Educate students on campus trees			
Action 2.2.1 Arbor Day observance			
Action 2.2.2 Have service-learning projects			

6.3 Tree Organizations in Richmond

Tree Organizations in Richmond

Additionally, there are several tree organizations in Richmond that VCU can collaborate with during the implementation of the campus tree plan. A list of the main tree organizations in the City was compiled with a brief summary of what each organization does in regard to tree care and planting.

Richmond Tree Stewards

Richmond Tree Stewards is an organization in Richmond whose mission is to "promote and improve the health of city trees to ensure the city's forest will survive and thrive". They do this by "increasing public awareness through community education, planning and planting for the future, and providing maintenance and care for young trees on streets and in parks" (richmondtreestewards.org). Richmond Tree Stewards conduct projects throughout the City of Richmond such as the Carver neighborhood tree-planting event to help benefit the urban forest. They also provide free trees to community groups (any non-profit organization, public/private schools etc. that care for spaces such as public parks) and assist them with tree plantings.

EnRichmond

EnRichmond is a non-profit organization that supports communities in Richmond through citizen involvement, education and fundraising (enrichmond.org). Within their group is TreeLab, a nonprofit greenhouse that grows locally sourced trees and plants to beautify and improve the City of Richmond. These native trees are grown locally, making them already adapted to our local climate, are available for purchase by businesses and other nonprofits. The TreeLab manager is also able to provide expert advice to citizen-led and nonprofit projects, as well as provide small-group educational opportunities.

Capital Trees

Capital Trees is a nonprofit organization devoted to designing, restoring and maintaining green spaces in Richmond through the thoughtful planning and planting of trees. As a public-private partnership, they "bring together the City, corporations, other nonprofits, foundations and individuals to create a greener, more beautiful, more livable city" (capitaltrees.org). Being a grass roots organization, a majority of their funding comes from individual donors and volunteers.

City of Richmond's Urban Forestry Division

In addition to these tree organizations, the City of Richmond also has an Urban Forestry Division within the Department of Public Works that is responsible for the maintenance of existing trees along with the planting of new trees through the city. The Urban Forestry Division also assists with community education regarding tree care in Richmond (richmondgov.com). The City also keeps a list of approved tree species for use in Richmond. Any tree plantings that take place in the City would have to come from that list. Appendix C contains notes from an interview with John Chupek (Urban Forestry Division) who provided some insight into the current state of trees in the city.

7. Conculsion

As VCU continues to expand, the University must work towards a more sustainable future for both its community and campuses. It is important for VCU to have a plan that addresses the trees and tree cover on its campuses as trees (particularly those in urban settings like VCU) provide a wide range of ecosystem services and benefits. The VCU Campus Tree Plan envisions a safe, healthy, attractive and sustainable urban forest for its campuses. This vision will guide the implementation of this plan over the coming years and decades. This plan provides the university with the framework and policy guidelines for the preservation, maintenance and eventual expansion of the urban tree canopy on its campuses. This Campus Tree Plan has the ability to ensure that trees and the UTC on VCU's campuses not only survive but also thrive heading into the future.

The implementation of this plan will provide the University with many tangible benefits such as a reduction in the urban heat island effect that VCU's campuses experience, mitigation of stormwater runoff during heavy precipitation events, increased physical and psychological well-being for residents, increased revenue for business owners and business districts and increased aesthetic appearances for neighborhoods and retail areas. All of these benefits will help enhance the overall environment for VCU's students and faculty and increase VCU's standing as a premier urban university. The success of this plan will primarily depend on the amount of implementation carried out by the VCU Offices of Sustainability, Planning & Design and Facilities Management. It is hoped that within the next couple decades VCU will have established itself as a well treed urban university.

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9.1 Appendix A: BMPs from Example Plans

Table 7: Tree Selection

Virginia Tech	o Both native and exotic tree species are used o Selects the best tree for a given site (site specific) o Ensures sufficient biological diversity of trees on campus o Ensures role for Campus Tree Advisory Committee in tree selection process
Georgia Tech	o Both native and exotic tree species are used o Selects the best tree for a given site (site specific) o Uses established criteria/guidelines for tree selection o Ensures sufficient biological diversity of trees on campus o Ensures role for Campus Tree Advisory Committee in tree selection process
Wake Forest University	o Uses established criteria/guidelines for tree selection (List of Recommended Trees) o Tree species shall be hardy to a minimum of USDA hardiness zone 7 and be pest resistant so as to minimize pesticide use and maintenance needs o Contains list of tree planting standards o Contains list of prohibited tree species o Ensures role for Campus Tree Advisory Committee in tree selection process o University Arborist & Director of Landscaping Services have final say on the appropriateness of species introduced to campus
University of Pennsylvania	o Both native and exotic tree species are used o Uses established criteria/guidelines for tree selection (utilizes Philly Parks and Rec Department guidelines) o Avoid planting trees that are considered “Fall planting hazards” o Selects the best tree for a given site (site specific) o Ensures sufficient biological diversity of trees on campus
Virginia State	o Uses established criteria/guidelines for tree selection (includes CPTED guidelines) o Selects the best tree for a given site (site specific) o Ensures sufficient biological diversity of trees on campus o Ensures role for Campus Tree Advisory Committee in tree selection process
Arbor Day Foundation	o Requires colleges to have campus tree care policies for planting o Calls for establishing a list of recommended and prohibited tree species

Table 8: Tree Maintenance

Virginia Tech	o Contains specific guidelines for pruning practices (Cleaning, thinning, raising) o Tree mulching- every two years for trees up to approximately 6". Periodically, drip lines of larger trees and tree groupings are mulched extensively with waste wood chips o Trees are treated for pest problems as needed o No regular tree fertilization beyond treatment received as a result of fall lawn fertilization. Specimen or high-value trees may receive prescription fertilization when severe nutrient deficiencies are diagnosed o Live trees are removed only when required to protect the public safety or are detracting from the quality of the landscape o Trees are removed after consultation with the Tree Advisory Committee where the committee reaches a consensus
Georgia Tech	o The tree team prunes trees annually through a preventive maintenance pruning program. All campus trees are periodically surveyed and rated based on their pruning needs to determine scheduling priorities (only broken or damaged branches should be pruned) o Newly planted trees should not receive fertilization during the first growing season except in a situation where a soil test recommends its use. A slow release type of fertilizer should be used around the tree basin o Staking of trees at planting is not required if the rootball is stable. If staking must be done, it will be done in accordance with ANSI most recent edition o When a tree removal request is made, a certified arborist evaluates the tree in question and makes the determination for removal or not based, on the result. If the tree is considered a hazardous tree, it is then scheduled for removal (All hazardous trees have two things in common, a significant defect and a potential target for falling on a building, car or pedestrian). Most tree removals are done by staff or contractor o In the event of severe weather conditions such as tornadoes or hurricanes, falling trees will be removed by Landscape Services staff or an outside tree removal company

Wake Forest University	o Contains specific guidelines for pruning practices (Cleaning, thinning, raising, reduction) o Mulching: Every two years for trees up to approximately 6". Periodically, drip lines of larger trees and tree grouping are mulched extensively with waste woodchips o Irrigation: New shrub and tree planting is hand watered from a spigot or a mobile water tank. Newly planted trees shall receive one inch supplemental water per week in the absence of 1 or more inches rainfall, for the first two years through the automatic sprinkler system or through hand-watering o Fertilization: There is no regular tree fertilization beyond treatment received as a result of lawn fertilization. Individual trees may receive prescription fertilization when severe nutrient deficiencies are diagnosed o Pest Management: Most pest management is handled through the university's integrated pest management plan, though trees may be treated for pest problems as needed. Should a pest infestation be suspected, the University Arborist should be contacted o Trees are generally removed only when required to protect the public safety, when they interfere with construction, or detract from the quality of the landscape o Contains a list of prohibited practices
University of Pennsylvania	o Contains detailed information on site preparation for tree planting o Contains specific guidelines for pruning practices o Fertilize trees only if the need to do so is indicated by soil testing o Monitor trees throughout the growing season to determine if supplemental watering is necessary in addition to any existing above-ground irrigation. In the case of drought, provide an additional 1" of water weekly in the root zone o Trees are to be transplanted when they are dormant, avoiding of "Fall Hazard" species, which should be moved only in early spring o Contains detailed protection and preservation policies and procedures o Contains list of prohibited practices

Virginia State	o Contains specific guidelines for pruning practices (Cleaning, thinning, raising, reduction) o Contains specific guidelines for mulching o Trees if properly mulched, do not need constant irrigation. They need irrigation during periods of drought o No need for a regular fertilization program (only on a case by case situation). A soil test will be performed prior to fertilization to determine the pH and what nutrients are needed o Pest management; periodic visual (quarterly) inspection of the campus forest will be performed by Urban Forestry Exten. and the results recorded in a management file. In the event a catastrophic pest outbreak occurs on the campus the pest will be treated as soon as detected by the recommended method o Trees should be removed only when they are a safety concern, are detracting from the quality of the landscape, or when absolutely necessary for new construction projects. In the case of construction, consideration should be given to ways to leave as many trees as possible intact (Certified Arborist should help determine which tree(s) are salvageable and what procedures are needed to reduce the impact on the trees to be left o Contains list of prohibited practices
Arbor Day Foundation	o Requires campus tree care policies for landscaping, maintenance and removal o Protection and Preservation policies and procedures - include process for implementing tree protection plan including step-by-step process that every project must follow including construction and trenching o Tree damage assessment - enforcement, penalties, and appeals o Must have list of Prohibited Practices o Definitions of terminology related to campus trees o Communication strategy - how the campus tree care plan will be communicated to the college community and contractors to heighten awareness about policies and procedures as well as the goals of the institution

Table 9: Oversight and Administration

Virginia Tech	o Responsible department is listed as VA Tech Grounds Department (located within Facilities Department) o The campus tree advisory committee meets biannually, and provides important input in to care and improvement of the campus landscape
Georgia Tech	o The responsibility of the Campus Tree Care Plan rests with Georgia Tech Facilities Department o Campus Tree Advisory Committee members are expected to actively participate and contribute in policy/guideline issues as well as research/information gathering that would aid in the campus tree care plan
Wake Forest University	o Responsible department is listed as Facilities and Campus Services (Landscaping Services) o The Campus Tree Advisory Committee will advise the university on proposed modifications to campus open space and landscaping; develop and maintain a list of satisfactory and desired species of trees; encourage the use of an appropriate variety of plant materials in new plantings; and make recommendations on landscape renovations and maintenance
University of Pennsylvania	o The University of Pennsylvania's Facilities and Real Estate Services (FRES) department is responsible for both the Campus Tree Care Plan and enforcement of the Plan o Campus Tree Advisory Committee members are expected to review all current policies and guidelines, any information or research gathered that might positively influence the plan and make any suggestions/changes when need be
Virginia State	o Department responsible for the implantation of the plan is listed as VSU Capital Outlay and Facilities Management Department o Campus Tree Advisory Committee will be convened at least twice per year (during Fall and Spring semesters)
Arbor Day Foundation	o Requires having a responsible authority/department - who enforces the Campus Tree Care Plan o Requires establishment of a Campus Tree Advisory Committee, terms of the representatives, and role committee plays o Campus Tree Advisory Committee must include a representative from each of the following audience: Student, Faculty, Facility Management, Community

Table 10: Learning Connections

Virginia Tech	o Not listed
Georgia Tech	o Holds a Campus Beautification Day each year in April where students, faculty and staff volunteer participate in tree planting and maintenance
Wake Forest University	o The Adopt an Area Program encourages service from the university's Greek Life community with the goal of 100 percent participation from individual Greek organizations as well as the Pan-Greek organizations on campus. Groups can become involved through participation in a campus cleanup, having a scheduled workday each semester or adopt an area of campus for continued care)
University of Pennsylvania	o Penn Class Tree Program-Every year the freshman class selects a new tree to be dedicated and planted on campus in honor of their class o Tree ID Tagging Program- Penn students tag significant trees with 3.5" x 5" metal tree identification tags o Arboretum Tree Donation- Penn began planting and maintaining interesting trees from the Morris Arboretum o Several other service learning/outreach type projects included in the plan
Virginia State	o Not listed
Arbor Day Foundation	o The Service Learning Project should be an outreach of the spirit of the Tree Campus USA initiative. This project should provide an opportunity to engage the student population with projects related to trees and can be part of a campus or community initiative. The project must be done within the course of the year application is submitted

Table 11: UTC Percentage Coverage Goals

Virginia Tech	o Calls for increasing the campus tree canopy (no specific number provided)
Georgia Tech	o Facilitate the achievement of 55% tree canopy on campus o Facilitate the achievement of 22% woodlands coverage on campus o Complete a Campus Tree Inventory (GIS) o Protect and maintain the campus urban forest by managing the impact of development and constructions on campus trees o Provide protection and to make sure that removal of all trees on campus are conducted with proper considerations and adequate replacement program
Wake Forest University	o Not listed
University of Pennsylvania	o Not listed
Virginia State	o Calls for increasing campus tree cover (no specific number provided) o Calls for reduction in number of tree removals
D.C Urban Tree Canopy Plan	o Called for establishing and maintaining a 40% tree canopy goal by 2032 o Aim to plant a total of 216,300 trees over the next 20 years (10,800 trees per year)
City of Charlottessvile Urban Forest Management Plan	o Called for establishing and maintaining a 40% tree canopy goal over the coming years
Town of Leesburg Urban Forest Management Plan	o Called for establishing and maintaining a 40% tree canopy goal over the coming years
Arbor Day Foundation	o Requires colleges to develop at least one goal and target for their Campus Tree Plan. These can include (but not limited to) tree canopy target, development of a link between the Campus Tree Plan and other green initiatives on campus or in the community; completion of a campus-wide tree inventory, etc. Include how the goal will be measured

9.2 Appendix B: Strategies and Approaches for Adapting Urban Forests to Climate Change

The following is a list of climate change adaptation strategies and approaches for urban forests. Each approach contains specific examples of adaptation tactics which can be explored in more detail in the link provided in the references section below (Pages 55-73 in the PDF document).

Strategy 1. Sustain or restore fundamental ecological functions
1.1. Maintain or restore soils and nutrient cycling in urban areas.
1.2. Maintain or restore hydrology.
1.3. Maintain or restore riparian areas.
1.4. Reduce competition for moisture, nutrients, and light.
1.5. Restore or maintain fire in fire-adapted ecosystems.

Strategy 2. Reduce the impact of biological stressors
2.1. Maintain or improve the ability of forests to resist pests and pathogens.
2.2. Prevent the introduction and establishment of invasive plants and remove existing invasive species.
2.3. Manage herbivory to promote regeneration, growth, and form of desired species.

Strategy 3. Reduce the risk and long-term impacts of severe disturbances
3.1. Alter forest structure or composition to reduce risk or severity of wildfire.
3.2. Maintain trees and remove hazards to reduce severity or extent of wind and ice damage.

Strategy 4. Maintain or create refugia
4.1. Prioritize, maintain, and restore unique sites.
4.2. Prioritize and maintain sensitive or at-risk species or communities.
4.3. Establish artificial reserves for at-risk and displaced species.

Strategy 5. Maintain and enhance species and structural diversity
5.1. Promote diverse age structure.
5.2. Maintain and restore diversity of native species.
5.3. Retain biological legacies.
5.4. Establish reserves to maintain ecosystem diversity.

Strategy 6. Increase ecosystem redundancy across the landscape
6.1. Manage habitats over a range of sites and conditions.
6.2. Expand or buffer the boundaries of reserves to increase diversity.

Strategy 7. Promote landscape connectivity
7.1. Reduce landscape fragmentation.
7.2. Maintain and create habitat corridors through reforestation or restoration.

Strategy 8. Maintain and enhance genetic diversity
8.1. Use seeds, germplasm, and other genetic material from across a greater geographic range.
8.2. Favor existing genotypes that are better adapted to future conditions.
8.3. Use new genotypes that are better adapted to future threats and conditions.

Strategy 9. Facilitate composition adjustments through species transitions
9.1. Favor or restore native species that are expected to be adapted to future conditions.
9.2. Establish or encourage new mixes of native species.
9.3. Select tree species to match current and future site conditions.
9.4. Protect future-adapted seedlings and saplings.
9.5. Disfavor species that are distinctly maladapted.
9.6. Manage for species or genotypes with wide moisture and temperature tolerances.
9.7. Introduce species that are expected to be adapted to future conditions.
9.8. Move at-risk species to locations that are expected to provide habitat.

Strategy 10. Realign urban ecosystems after disturbance
10.1. Promptly revegetate sites after disturbance.
10.2. Prioritize remediation of remaining trees following disturbance.
10.3. Realign significantly disrupted ecosystems to meet expected future conditions.

9.3 Appendix C: Interview with John Chupek

Newly planted trees are in Richmond often struggle to survive because they have not acclimated to their new site well (Chupek, 2018). Native trees such as Ash tend to be more susceptible to pests (which could become an increased problem for trees in Richmond due to climate change). Early maintenance of new trees pays off big time and a crucial part of taking care of new trees is watering them. Not all tree species approved by the City of Richmond are permitted at any given site; City arborists must approve the tree for each site (Chupek, 2018). Currently Richmond is overusing varieties of oak and maple trees. Diversity of trees is a good thing and localities should try to plant non-native tree species, not just native species (The Gingko tree as an example of a good nonnative tree species to use). Clusters of diverse trees are also stronger together. Humans tend to be the biggest issue in terms of negative impacts on trees. Traffic, soil compression and the root zone constantly being compromised through construction and hardscaping are some of the key issues in urban environments (Chupek, 2018).